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ABSTRACT

The self-teaching text in map reading covers those skills needed by readers of military maps and map substitutes. It provides a foundation for personnel whose training program will require specialized or more advanced skills. Practical experience in the field with map and compass should supplement the text. The six parts of the text are meant to be studied sequentially. The six divisions are: symbols and marginal information, location, distance, direction, relief, and map supplements and substitutes. The text consists of frames (presenting a single teaching point which usually requires an answer to a specific problem) and panels (illustrations or other information needed to solve the problems in the frames). (Author/AG)

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PROGRAMMED TEXT

COMMON SKILLS IN MAP READING

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INTRODUCTION

This self-teaching text in map reading covers those skills needed by everyone who uses military maps and map substitutes. It provides a foundation for personnel whose training program will require specialized or more advanced skills. Study of this text should be supplemented by practical exercises in the field with map and compass.

The instructional material in this text consists of six parts. You should study them in the proper sequence — especially Parts I, II, and III. You will use what you learn about symbols, marginal information, point location, and distance measurement over and over again in subsequent parts. The six parts are as follows:

Part I.	Symbols and Marginal Information.
Part II.	Location
Part III.	Distance
Part IV.	Direction
Part V.	Relief
Part VI.	Map Supplements and Substitutes

ORGANIZATION OF TEXT

This text consists of **frames** and **panels.** A **frame** presents a single teaching point, which usually requires an answer to a specific problem. A **panel** is an illustration or other information needed to solve the problems in the frames.

The problem in some frames requires you to write an answer. In others, you select a correct choice and draw a circle around it. A few frames are called INFORMATION or REVIEW frames and do not need an answer. When the frame refers you to a panel, find the correct panel (printed after the frames) and study it before answering the question.

HOW TO STUDY

1. Start with frame 1 in Part I. Answer it correctly by drawing a circle around the correct choice in pencil.

2. Turn the page. The correct answer to frame 1 is printed in parentheses above frame 2 on page 1-3. If you were incorrect, turn back to frame 1 to re-study the frame and change your answer to the correct one. (Correcting wrong answers will help you remember the teaching point.)

3. Answer frame 2 by filling in the blanks with the correct words.

4. Turn the page. Check your answer as before and then work out frame 3 and continue in the same manner.

MATERIALS FURNISHED

You receive considerable practice with actual map-reading materials in this instruction. The following materials are essential in answering the frames in this text:

Topographic map: Kansas, 1:50,000, Leavenworth, Sheet 7062 IV

Photomap: Kansas photomaps, 1:50,000, Leavenworth, Sheet 7062 IV (Printed on back of Leavenworth topographic map.)

✓ **Pictomap:** Virginia, 1:25,000, Fort Belvoir and Vicinity, Special Map

(NOTE: Disregard the photomap and topographic map printed on the back of the furnished pictomap. References in this text to the Fort Belvoir and Vicinity Special Map are to the **Pictomap** only.)

Aerial photograph "A", M-109, Exposure 565

Map reading overlay, keyed to the Leavenworth topographic map.

Protractor with map scales

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PART I

SYMBOLS AND MARGINAL INFORMATION

Set 1-1. TOPOGRAPHIC SYMBOLS

FRAME 1.

A topographic map is a drawing of part of the earth's surface. Rivers, roads, woods, and hills are shown by lines, symbols, and colors. What is a military topographic map?

a. picture b. drawing

(brown) (11)

FRAME 12.

You are already "recognizing" roads, railroads, towns, swamps, and orchards. Even though the map is a drawing, it helps you "see" the ground from above. Find the same section of State Route 92 in the photomap printed on the reverse side of the map. Which view permits you to "see" State Route 92 more clearly?

a. topographic map b. photomap

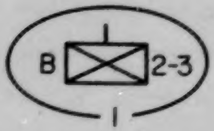
(b.) (22)

FRAME 23.

Certain Army units are identified by the Combat Arms Regimental System (panel 1-2). Under this system, the parent units are designated by both **battalion** and traditional **regimental** numbers. Under the Combat Arms Regimental System (CARS) both battalion and traditional ____________________ numbers are shown.

---

(33)



FRAME 34.

Refer to panels 1-4B and 1-5B and the Map Reading Overlay provided with this text. In which area is the minefield located?

a. friendly **b.** enemy

(b. drawing) (1)

FRAME 2.

Study the colors on the LEAVENWORTH map. Notice that five colors are used on it. As you would expect, **blue** shows water features and **green** shows vegetation. **Brown** shows elevations (hills and valley). The colors __________ and __________ show manmade features, such as highways and buildings.

(a. topographic map) (12)

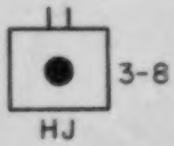
FRAME 13.

Manmade features (roads, buildings) are extremely important in planning military operations. The map maker wants you to "see" them clearly so he draws them a little larger than they would be on a photo. He uses colors and symbols. He is careful, however, to position the centers of the symbols correctly. The size of manmade features, such as roads and buildings, is often exaggerated on a map so the reader can _______________ them better.

(regimental) (23)

FRAME 24.

In writing the CARS symbol, **battalion** and **regimental** numbers are written together separated by a **dash**, for example 3-8. In the symbol below 3 means the 3d Battalion and 8 means the 8th ____________________.



(a. friendly) (34)

FRAME 35.

Refer to Panel 1-4B and the Map Reading Overlay. On the overlay, find circles with an X inside. What do these military symbols mean?

a. supply points

b. infantry headquarters

c. coordination points

(red, black) (2)

FRAME 3.

Bright red describes the main roads shown on the map. What does the lighter shade of red on the LEAVENWORTH map show?

a. railroads
b. churches and post offices
c. built-up areas

(see) (13)

FRAME 14.

FM 21-31, Topographic Symbols, defines approximately 250 symbols used by the map makers. However, the map legend contains all the symbols normally required by the map reader. When you find a topographic symbol that is neither self-explanatory nor explained in the legend, you should refer to FM __________-__________ if you need to know what it means.

(regiment) (24)

FRAME 25.

Draw the symbol for Company A, 8th Battalion, 33d Armor, 21st Armored Division, using the CARS system.

(c. coordination points) (35)

FRAME 36.

You are beginning to "see" troop units, supply points, minefields, and boundary lines in the military symbols drawn on a situation map or overlay. Since you cannot expect to memorize all such symbols before you begin using them, you use FM _______-_______ as a reference when necessary.

(c. built-up areas. Otherwise, a city would appear in black because of the symbols for buildings and would be hard to read.) (3)

FRAME 4.

You have learned that 5 colors are used on a large-scale topographic map to show the different features on the earth's surface. Write the correct color or colors in the space after each of the following:

a. woods and orchards ____________

b. contour lines ____________

c. rivers and lakes ____________

d. roads ____________ and ____________

e. built-up areas ____________

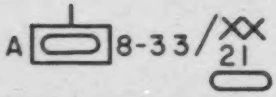
Set 1-2. MILITARY SYMBOLS

(21-31. Memorizing all topographic symbols before you need them is impractical. You will learn them more effectively through usage.) (14)

FRAME 15.

The military map user often wants to "see" the military situation — location of friendly and enemy units, command posts, observation points, supply points, weapons, defenses, unit boundaries, and so on. These are shown by **military** symbols. A situation map shows a tactical or administrative situation on the ground by what kind of symbols?

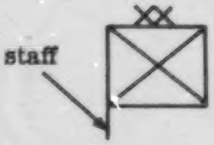
a. topographic   b. military



(25)

FRAME 26.

Field headquarters of units (Panels 1-1 and 1-4a) are shown by the symbol with a **staff** attached as shown below. The end of the staff indicates the exact location. The unit symbol with ________________________ indicates a field headquarters.



Set 1-3. MARGINAL INFORMATION

(21-30) (36)

FRAME 37.

On the LEAVENWORTH map, you found the map symbols in the marginal information. Later, the marginal information will help you locate points, measure distance, and find directions and elevations. The map reader needs to understand and use ____________________ information correctly.

(a. green; b. brown; c. blue; d. red and black; e. red) (4)

FRAME 5.

The symbols and colors used on a military map are explained in the **legend.** Find the legend on the LEAVENWORTH map. In what part of the map margin is the legend located?

a. top center b. lower left

(b. military) (15)

FRAME 16.

Panels 1-1 through 1-5 printed at the end of Part I show the military symbols commonly used on situation maps and overlays. They are extracted from FM 21-30. Once you learn the system, you recognize symbols with practice. When you find one that you do not understand, you should look it up in FM ______-______.

(staff) (26)

FRAME 27.

In the space below, draw the symbol for an infantry company headquarters.

(marginal) (37)

FRAME 38.

In addition, marginal information enables you to identify maps so that you can requisition them properly and be sure that all users are referring to the same sheets. Specific military maps can be identified by referring to the ______________________ information.

1—10

(b. lower left) (5)

FRAME 6.

Refer to the LEAVENWORTH map. Find where the Chicago, Burlington, and Quincy Railroad enters the map from the south (bottom right). What does the symbol tell you about this railroad?

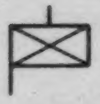
a. single track b. multiple track

(21-30) (16)

FRAME 17.

Refer to Panel 1-1. What is the shape of the symbol denoting a military unit, such as a company, battalion, or division?

a. round b. triangular c. rectangular

() (27)

FRAME 28.

A field headquarters is shown by the unit symbol and a ________________ which indicates the unit's exact location.

(marginal) (38)

FRAME 39.

Each map is called a sheet by the map makers. The sheet is named after the most prominent feature shown on the map. The sheet name is printed in the top center margin. Refer to your LEAVENWORTH map. The sheet name is ________________.

(b. multiple track) (6)

FRAME 7.

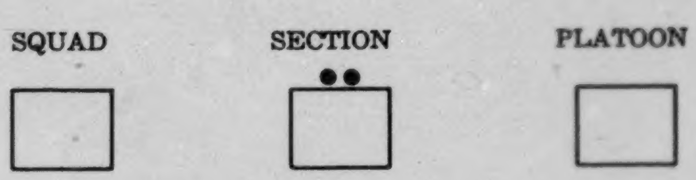
Refer to the LEAVENWORTH map. Follow the Chicago, Burlington, and Quincy Railroad upwards past Horseshoe Lake and the town of Farley. Before you get to Green Cemetery there is some swamp or marsh on the left side of the tracks. What tells you this is a swamp?

a. symbol and color **b.** words

(c. rectangular) (17)

FRAME 18.

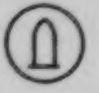
Symbols indicating the size of the unit are placed at the top of the rectangle. Small units of squad, section and platoon size are shown with 1, 2, or 3 dots respectively. Refer to Panel 1-1. Complete the appropriate size identifications on the troop units shown below by putting the right number of dots over the squad and platoon symbols.

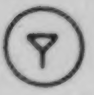


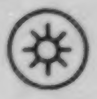
(staff) (28)

FRAME 29.

Refer to Panel 1-3. Which of the following symbols shows an ammunition supply point?

a. 

b. 

c. 

(Leavenworth) (39)

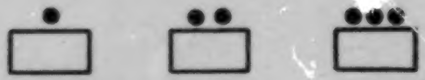
FRAME 40.

The series name defines the larger geographic area covered by a group of sheets. It is often a state or a country. The series name is printed in the upper left margin. Refer to the LEAVENWORTH map. Its series name is ____________.

(a. symbol and color) (7)

FRAME 8.

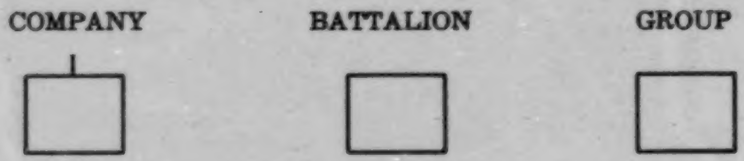
You were able to identify the symbol for a swamp area by checking the ________________ in the lower left margin of the LEAVENWORTH map.

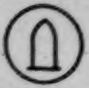


(squad section platoon) (18)

FRAME 19.

One, two, or three short vertical lines indicate units of company, battalion, and group (or regiment) size. Refer to Panel 1-1. Place the correct number of vertical lines over the battalion and group symbols.



(a. ) (29)

FRAME 30.

Refer to the overlay furnished with this text. When this overlay is correctly placed over the LEAVENWORTH map, it shows a tactical situation on the northwest (upper left) portion of the map. The military situation is shown on the overlay by ______________ ______________.

(Kansas) (40)

FRAME 41.

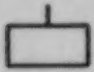
To shorten the sheet name and series name identification, a **sheet number** is printed in the upper right corner of the map. On very recent maps, it is also shown in the lower left corner. Refer to the LEAVENWORTH map. The **sheet number** for the Leavenworth, Kansas 1:50,000 map is __________________.

(legend) (8)

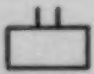
FRAME 9.

Refer to the left edge of the LEAVENWORTH map. Find where State Route 92 enters the map and trace it to the top of Knob Ridge (just before it turns right into Leavenworth). What tells you this is a state route rather than a Federal route?

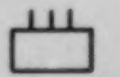
a. color b. symbol



(company



battalion



group) (19)

Larger units are identified by one or more letters X. Refer to Panel 1-1. Place the appropriate size identification on the units indicated below as required.

BRIGADE DIVISION CORPS

ARMY ARMY GROUP

(military symbols) (30)

FRAME 31.

Panels 1-4 and 1-5 describe the main military symbols used on situation maps and overlays. From Panel 1-4 and other panels, draw the symbol which would show the future location of the 2d Infantry Bn Headquarters.

(7062 IV) (41)

FRAME 42.

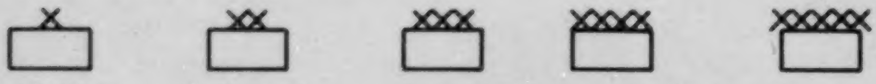
In the lower right corner of the LEAVENWORTH map is a diagram showing the Index to Adjoining Sheets. It identifies the sheet numbers surrounding your map. Note that sheet number of the LEAVENWORTH map, 7062 IV, is in the heavily outlined box. If you needed the sheet to the left of your map you would ask for sheet number __________.

(b. symbol) (9)

FRAME 10.

Refer again to State Route 92 on the LEAVENWORTH map. On the right side of the road just above the word **Knob** is an orchard. How do you know this is an orchard instead of a vineyard or a woods?

a. color b. symbol

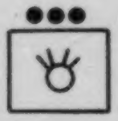


(brigade division corps army army group) (20)

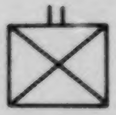
FRAME 21.

In addition to size, the arm or branch of service of the unit is indicated by a symbol inside the rectangle. Refer to Panel 1-1. Which of the following symbols represents an artillery battalion?

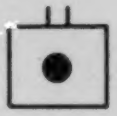
a.

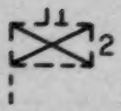


b.



c.

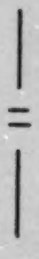


() (31)

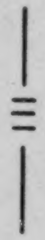
FRAME 32.

Refer to Panel 1-4D. On a situation map, which of the following would show the boundary between two battalions?

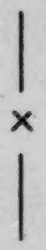
a.



b.



c.



(6962 I) (42)

FRAME 43.

Examine the numbering and you will see four "7062" maps in a group. The upper right one is labeled I and the others increase clockwise (II, III, and IV). To the left of 7062 IV is 6962 I. What is the sheet number of the **next** sheet to the left of 6962 I?

a. 6962 III b. 6962 IV c. 6862 I d. 7062 IV

(b. symbol) (10)

FRAME 11.

Refer again to the orchard near State Route 92. In the eastern (right) half of the orchard, find the figure 1100 inserted in a brown line. This means that the hill along that particular line is 1100 feet above sea level. You can tell that the 1100 means elevation rather than something else because the number is printed in a ________________ color.

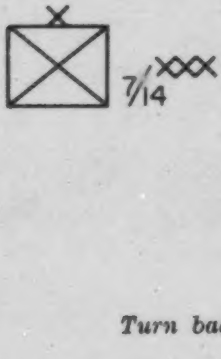
Turn back to bottom of page 1-1 for frame 12

(c. . The round black dot means artillery and the two lines indicate a battalion.) (21)

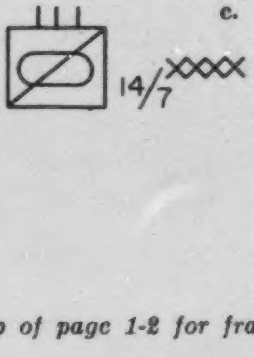
FRAME 22.

Refer to Panels 1-1 and 1-2. Using what you learned in previous frames, which of the following symbols would identify the 14th Armored Cavalry Regiment, 7th Army?

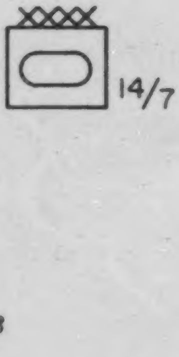
a. a.



b. b.



c. c.



Turn back to top of page 1-2 for frame 23

(a.) (32)

FRAME 33.

Again refer to Panel 1-4D. Draw the symbol that would show the defensive area held by B company, 2d Battalion, 3d Infantry.

Turn back to bottom of page 1-2 for frame 34

(b. 6962 IV. If you didn't select this answer, the diagram below illustrates the numbering.) (43)

6963 III	6963 II	7063 III	7063 II
6962 IV	6962 I	7062 IV	7062 I
6962 III	6962 II	7062 III	7062 II

FRAME 44.

In addition to the sheet number, a **series number** assigned by the U. S. Army Topographic Command (TOPOCOM) gives coded information about the map sheet, such as the region of the earth where it falls, and the scale of the map. The series number is printed beneath or next to the sheet number. The series number of the LEAVENWORTH map is ________.

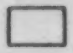
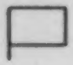
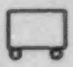
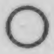
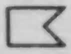
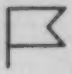
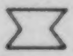
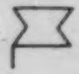
(V778) (44)

END OF FRAMES FOR PART I

PANEL 1-1

UNITS AND INSTALLATIONS

Geometric figures form the basic symbols used to represent units and installations. Examples of the more common figures are as follows:

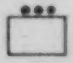
A unit (a rectangle)	
A field headquarters or headquarters echelon of a unit (Staff is always to the left)	
An observation or listening post	
Combat service support elements of U. S. combat units (brigade trains and below)	
A logistical installation or activity:	
A combat service support unit that performs duties as a part of a field army support command	
A headquarters or headquarters echelon of a field army support command combat service support unit. (Staff is always to the left)	
A combat service support unit that performs duties within the communications zone	
A headquarters or headquarters echelon of a combat service support unit within the communications zone	

SIZE INDICATION

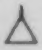
To show the size of a specific unit or activity, the appropriate size indication is placed on top of the basic symbol.

Squad	•
Section or unit larger than squad but smaller than a platoon.	• •
Platoon or Detachment	• • •
Company, Battery, or Troop	I
Battalion or Squadron	II
Group or Regiment	III
Brigade or Equivalent Command	X
Division	XX
Corps	XXX
Army	XXXX
Army Group	XXXXX

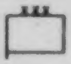
Examples:



(A platoon)

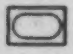
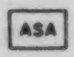
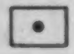
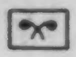
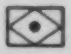
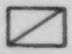
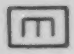
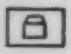
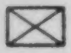
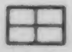
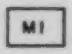
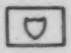
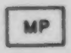
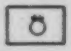
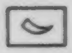
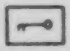
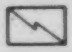
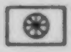
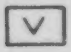


(A company observation post)



(A corps headquarters)

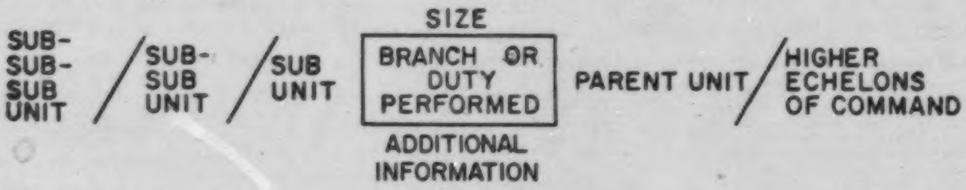
ARM OR BRANCH OF SERVICE

Arm or Branch	Symbol
Armor	
Army Security Agency	 ASA
Artillery	
Chemical (CBR)	
Coast Artillery (Foreign Armies only)	
Cavalry (Reconnaissance)	
Engineer	
Finance (Pay)	
Infantry	
Medical	
Military Intelligence	 MI
Military Government or Civil Affairs	
Military Police	 MP
Ordnance	
Postal	
Quartermaster	
Signal	
Transportation	
Veterinary	

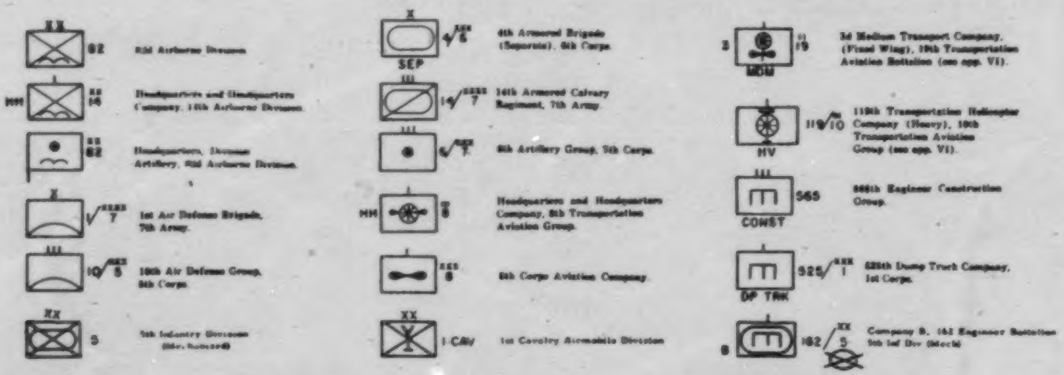
PANEL 1-2

UNIT DESIGNATION AND BASIC SYMBOL

To indicate a particular unit or installation, *the parent unit designation is placed immediately to the right of the basic unit or installation symbol;* additionally, the parent unit may be underlined. Higher echelons of command follow to the right of the parent unit designation. To the left of the basic symbol, subordinate units are shown. Slashes separate command echelons. Only cardinal numerals are used. The arrangement of various combinations of symbols to depict specific units or installation is shown in the following diagram:


SUB-SUB-SUB UNIT
SUB-SUB UNIT
SUB UNIT
SIZE
BRANCH OR DUTY PERFORMED
ADDITIONAL INFORMATION
PARENT UNIT
HIGHER ECHELONS OF COMMAND

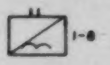
If only one type of unit is assigned to a military organization and if the unit is adequately identified by other military symbols, its designation may be omitted.


82
82d Airborne Division.
HH 14
Headquarters and Headquarters Company, 14th Airborne Division.
82
Headquarters, Division Artillery, 82d Airborne Division.
7
1st Air Defense Brigade, 7th Army.
10/5
10th Air Defense Group, 8th Corps.
5
5th Infantry Division (Mechanized)
SEP
4/6
4th Armored Brigade (Separate), 6th Corps.
14/7
14th Armored Calvary Regiment, 7th Army.
8/7
8th Artillery Group, 7th Corps.
HH 8
Headquarters and Headquarters Company, 8th Transportation Aviation Group.
8
8th Corps Aviation Company.
1-CAV
1st Cavalry Airmobile Division
3 19
MDM
3d Medium Transport Company, (Fixed Wing), 19th Transportation Aviation Battalion (see app. VI).
119/10
HV
119th Transportation Helicopter Company (Heavy), 10th Transportation Aviation Group (see app. VI).
565
CONST
565th Engineer Construction Group.
525/1
DP TRK
525th Dump Truck Company, 1st Corps.
B 162/5
Company B, 162 Engineer Battalion 5th Inf Div (Mech)

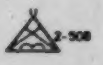
PANEL 1-2 (Continued)

COMBAT ARMS REGIMENTAL SYSTEM (CARS)

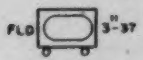
Sometimes, parent units are identified by a combination of unit designations. Such a procedure is employed by many units within the U. S. Army and is known as the *Combat Arms Regimental System (CARS)*. Under the CARS system, parent units are designated by both the battalion (squadron) and traditional regimental numbers. To avoid confusion with different levels of command, *both numerical designations are always written together and separated by a dash rather than slashes.*



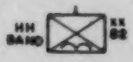
1st Reconnaissance Squadron, (Airborne) 8th Cavalry.



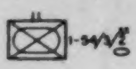
2d Battalion, Observation Post, 508th Airborne Infantry.



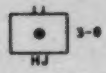
Field Trains, 3d Tank Battalion, 37th Armor.



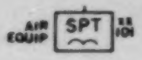
Headquarters, Headquarters Company and Band, 82d Airborne Division.



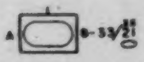
1st Battalion (Mechanized), 54th Infantry, 3d Brigade, 2d Armored Division.



3d Battalion (Honest John) 8th Artillery.



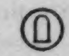
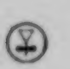
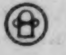
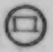
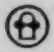
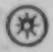
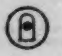
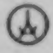
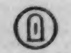
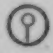
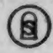
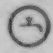
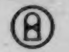
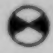
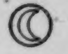
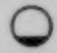
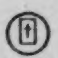
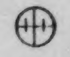
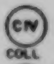
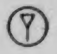
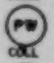
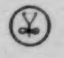
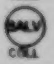
Air Equipment Support Company, 101st Airborne Division.



Company A, 6th Battalion, 33d Armor, 21st Armored Division.

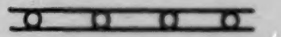
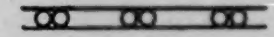
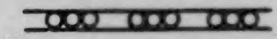
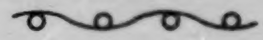
PANEL 1-3

LOGISTICAL AND MEDICAL INSTALLATIONS

Designation	Symbol	Designation	Symbol
Ammunition — any type		Petroleum, oils and lubricants — Army — Aviation	
Ammunition — Air Force		Solid fuel	
Ammunition — Army Aviation		Repair parts	
Ammunition — Artillery		Topographic	
Ammunition — rocket and guided missile		Traffic	
Ammunition — special		Water	
Ammunition — small arms		Parking	
Food Supplies		Class II and IV	
Graves service		Collecting points:	
Hospital, aid station		a. Civilian	
Petroleum, oils and lubricants		b. Prisoner of war	
Petroleum, oils and lubricants — Air Force		c. Salvage	

PIPELINES

Pipelines for refined petroleum products (indicate size in inches, if required) are shown as:

a. One line	
b. Two lines	
c. Three lines	
d. Submerged (one line)	

PANEL 1-4A

SITUATION MAPS AND OVERLAYS

COLORS

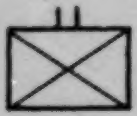
a. Colors in conjunction with military symbols denote the following:
  (1) Blue or *Black* — Friendly units, installation, equipment, and activities.
  (2) Red — Enemy units, installations, equipment, and activities.
  (3) Yellow — Friendly or enemy areas of chemical, biological, or radiological contamination.
  (4) Green — Friendly or enemy man-made obstacles.
b. If other colors are used, a suitable explanation in the margin or legend is given.

PRESENT AND PROPOSED LOCATIONS

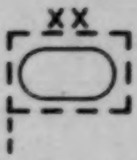
Basic unit and installation symbols are drawn with either solid or broken lines. The lower left-hand corner of the symbol indicates the location.

a. A solid line represents a present or actual location.
b. A broken line indicates a future or projected location.

Examples:



(The location of an infantry battalion)

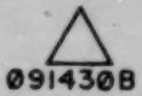


(The projected location of the headquarters of an armored division)

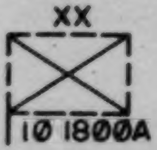
DATE-TIME GROUPS

Dates and times such as the opening of an installation or the expected arrival of a unit in a new location may be written under or inside the symbol. Date-time groups are used:

Examples:



(Present location of an observation post which opened at 1430 hours, Time Zone B, the 9th of the month).

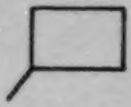


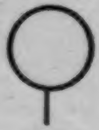
(Future location of the headquarters of an infantry division which is scheduled to open at 1800 hours, Time Zone A, the 10th of the month).

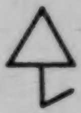
PRECISE LOCATIONS

Basic symbols other than the headquarters symbol may be placed on a central staff which is extended or bent as required. The end of the staff indicates exact location.

Examples:







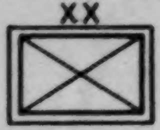
PANEL 1-4B

ENEMY FORCES

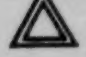
a. In general, the symbols shown in this manual are adequate for depicting both enemy and foreign units, weapons, equipment, and activities. When representing unorthodox units and equipment, the most appropriate symbol contained herein should be selected.

b. If only one color is available, enemy symbols are outlined with double lines.

Examples:



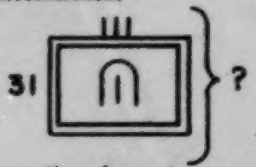
(Enemy infantry division)



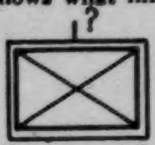
(Enemy observation post)

c. A question mark used in conjunction with an enemy symbol indicates unknown or unconfirmed information. The position of the question mark shows what information is unknown or unconfirmed.

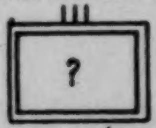
Examples:



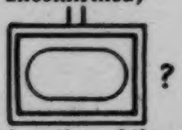
(All information shown is unconfirmed)



(The size of the enemy infantry unit is unconfirmed)



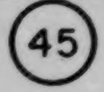
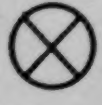
(The type of enemy regiment is unknown)



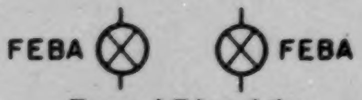
(The unit designation of the enemy tank battalion is unknown)

CONTROL POINTS

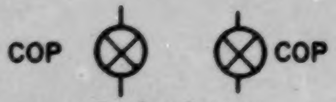
Control points are drawn on the selected terrain feature and identified as shown below.

Explanation and Remarks	Symbol
A *check point* consists of a circle inclosing a selected terrain feature with a number placed inside the circle	
A coordination point is shown by drawing a circle on the selected terrain feature and placing an "X" in the center. Coordination points are used in conjunction with boundaries to designate defensive areas.	

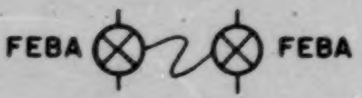
Examples:



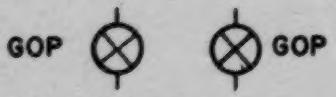
Forward Edge of the Battle Area.



Combat Outpost



Trace of the Forward Edge of the Battle Area.



General Outpost

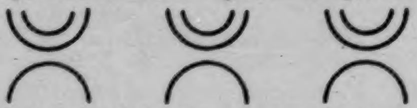
PANEL 1-4C

SITUATION MAPS AND OVERLAYS

FRONT LINES

a. Front lines are marked by a series of lines which curve away from opposing forces. If only one color is used, enemy front lines are represented by double lines.

Example:



b. Thinly held or patrolled parts of the lines are marked as a series of dots. If only one color is used, thinly held enemy lines are represented by open dots. The dots do not indicate strength or location of patrols.

Example:

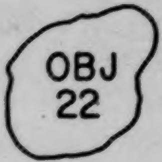
○ ○ ○ ○ ○ ○ ○

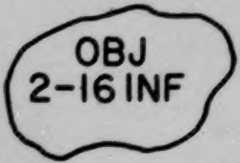
● ● ● ● ● ● ●

OBJECTIVES

Objectives and intermediate objectives are inclosed and identified by the abbreviation OBJ and a number, letter, code name, or unit designation.

Examples:

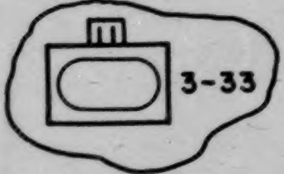




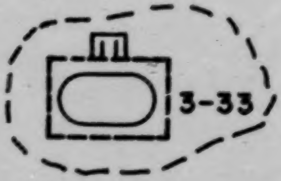
ASSEMBLY AREAS (UNDEFENDED AREA)

Assembly areas are inclosed and the unit symbol is placed in the center. Proposed assembly areas are shown with broken lines.

Examples:



(Assembly Area, Task Force, 3d Tank Battalion, 33 Armor)



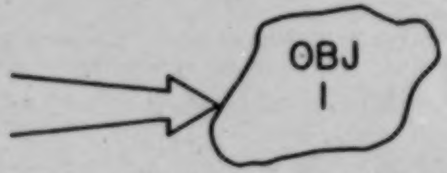
(Proposed Assembly Area, Task Force, 3d Tank Battalion, 33 Armor)

PANEL 1-4C (Continued)

AXIS OF ADVANCE

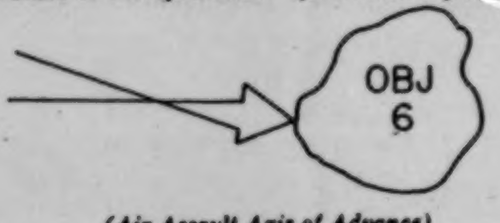
a. An axis of advance is normally assigned a code name or unit designation. The open arrow indicates the general route to be followed. A proposed axis of advance is shown in broken lines and labeled with the time or condition when effective. The point of the arrow touches the objective.

Example:



b. To differentiate between a ground axis of advance and an *air assault axis of advance,* a twist is placed in the shaft of the open arrow symbolic of a propeller.

Example:

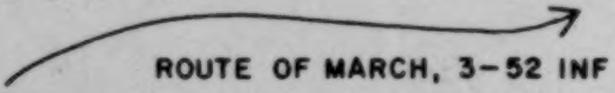


(Air Assault Axis of Advance)

DIRECTION OF ATTACK AND ROUTES OF MARCH

A direction of attack arrow is not labeled. Routes of march (advance, withdrawal, main supply, etc.) however, are labeled with their purpose and code name or unit designation. The arrow follows the specific route.

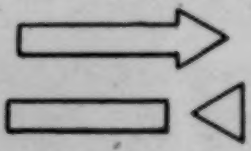
Example:



CONVOYS

a. Convoys of vehicles are represented by an arrow in the direction of movement; the point of arrow indicates the location of the head of the column.

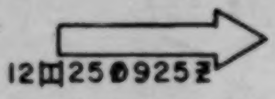
Examples:



(If the convoy is halted, the arrow is shown facing toward the rear of the column)

b. This symbol may be shown with the appropriate vehicle symbol to indicate the type and number of vehicles in the column. Likewise, the date and time may be added.

Example:



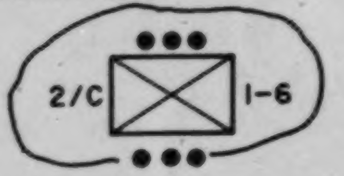
(A column of 12 medium tanks at 0925 Z hours on the 25th)

PANEL 1-4D

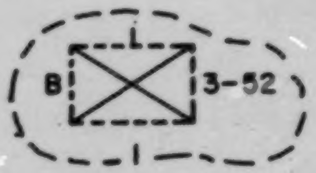
DEFENDED AREAS

If an area is occupied and defense of the area is prepared, a line including the size symbol of the defending unit incloses the area; the closed side of the symbol is oriented toward the most likely enemy threat. If desired, the military symbol of the defending unit may be entered in the center of the inclosed area.

Examples:



(Defensive area, 2d Platoon, C Company, 1st Battalion, 6th Infantry)

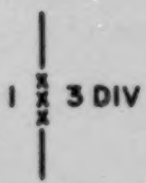


Proposed (Defensive area, B Company, 3d Battalion, 52d Infantry)

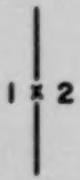
LATERAL BOUNDARIES

Boundaries are marked by a solid line with the size indication of the unit shown at convenient intervals. The designations of units supplemented by arm or branch and national designation, if necessary, are placed on either side of the size indication. If a lateral boundary separates units of unequal size, the symbol for the larger is used.

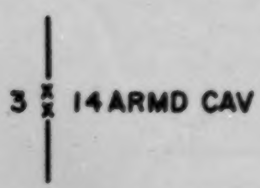
Examples:



(Boundary separates 1st Corps and 3d Division)



(Boundary separates 1st and 2d Brigades)

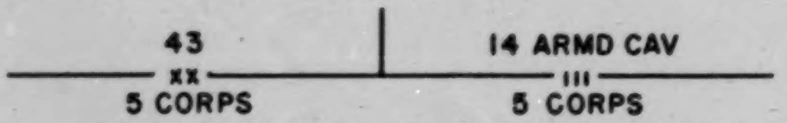


(Boundary separates 3d Division and 14th Armored Cavalry Regiment)

REAR BOUNDARIES

If a rear boundary is shown, the size indication along the boundary corresponds to the smaller unit or, in other words, to the commanded unit and not the commanding unit. Arm or branch and nationality of units are shown when required to prevent confusion.

Examples:



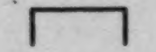
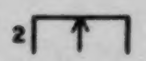
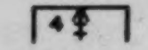
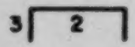
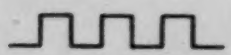
(Rear boundary separates 43d Division and 5th Corps)

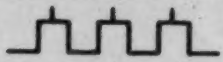
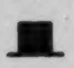
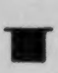
(Rear boundary separates 14th Armored Cavalry Regiment and 5th Corps)

PANEL 1-5A

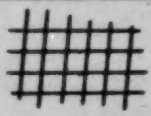
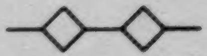
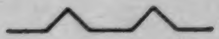
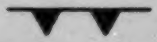
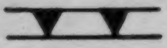
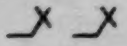
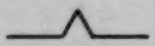
FORTIFICATION AND OBSTACLE SYMBOLS

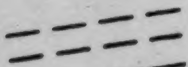
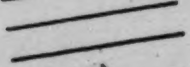
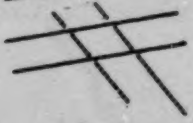
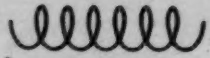
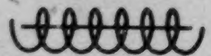
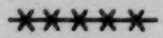
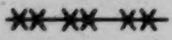
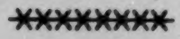
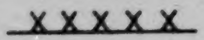
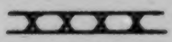
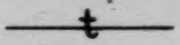
FORTIFICATION SYMBOLS

Fortification	Symbol
Weapon slit, foxhole or emplacement	
Two emplacements of light machine guns	
Emplacement for a four-barreled heavy machine gun	
Three foxholes for two men	
Any trench system	

Fortification	Symbol
Trench with firing bays	
Dug-out	■
Surface shelter (above ground)	
Underground shelter	
Pill box or casemate	□

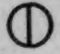
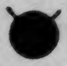
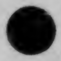
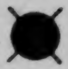
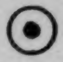
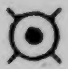
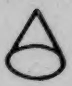
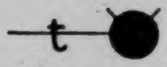
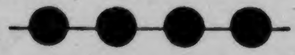
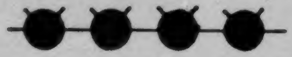
OBSTACLES OTHER THAN MINES

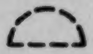
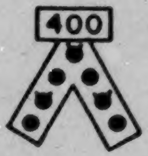
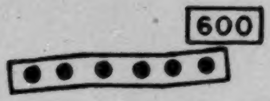
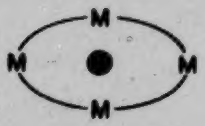
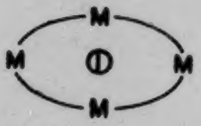
Obstacle	Symbol
Demolished area	
Tank obstacle, type unspecified	
Tank wall or bank	
Tank ditch	
Tank ditch covered	
Stakes, or rails or similar obstacles	
Tetrahedron, dragons' teeth and other similar obstacles	
Fixed	
Fixed and prefabricated	▲
Movable	
Movable and prefabricated	

Obstacle	Symbol
Road blocks, craters, and blown bridges:	
Proposed	
Prepared but passable	
Completed	
Wire	
Type unspecified	X X X X X
Concertina, single	
Concertina, multiple	
Single fence	
Double fence	
Double apron fence	
Low wire fence	
High wire fence	
Tripwire	

PANEL 1-5B

MINES

Explanation of Symbol	Symbol
Mines, type unknown	
Mines, antipersonnel	
Mines, antitank	
Mines, antitank, boobytrapped	
Double antitank mines	
Boobytrapped double antitank mines	
Boobytraps	
Antipersonnel mines connected to tripwire	
Row of antitank mines	
Row of antipersonnel mines	

Explanation of Symbol	Symbol
Cluster of mines	
Minefield	
Minefield of 400 mixed antitank and antipersonnel mines	
Minefield of 600 antitank mines	
Boundaries	
Unfenced antitank minefield	
Unfenced with type of mines unknown	

PART II

LOCATION

Set 2-1. POINT LOCATION BY GRID COORDINATES

FRAME 1.

A grid is a network of evenly spaced horizontal and vertical lines. These lines form squares on a military map to help locate points (targets, road junctions, command posts, and so on) quickly and accurately. The grid on a map consists of squares formed by ________________ and ________________ lines.

(a. 3553 (If you marked 5335 you made the mistake of placing the northing number first)) (14)

FRAME 15.

Find the Federal Penitentiary located just north of the city of Leavenworth. What are the grid coordinates of the grid square in which most of the penitentiary is located?

a. 3256

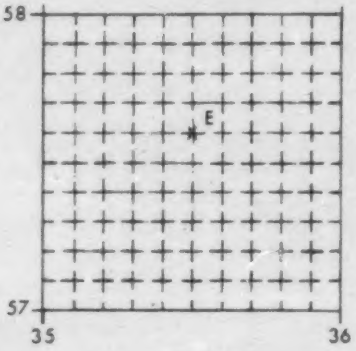
b. 3355

c. 3454

(a. 352578) (28)

FRAME 29.

Practice what you have learned about writing grid coordinates. Write the 6-digit coordinates for point E. ____________________



(b. 3855) (42)

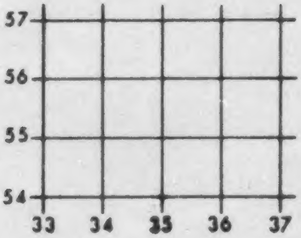
FRAME 43.

The 6-digit coordinates locate points on the LEAVENWORTH map to within 100 meters of their actual location on the ground. Writing 8-digit coordinates gives 10-meter accuracy. In 8-digit coordinates the 4th digit is added to the left-to-right reading and the 8th is an addition to the ____________________ reading.

(horizontal, vertical) (1)

FRAME 2. INFORMATION FRAME.

The horizontal and vertical lines are numbered in sequence. In the figure below, the vertical grid lines are numbered 33, 34, 35, 36 and 37, reading to the east from left to right. Because they measure distances **eastward** they are called "**eastings**". Reading north, from the bottom up, the horizontal grid lines are numbered 54, 55, 56, and 57. Because these horizontal lines measure distances **northward**, they are called "**northings**".



(b. 3355 (Grid line 33 (to the right) and 55 (up) cross at the lower left corner of the grid square in which the major part of the penitentiary is located)) (15)

FRAME 16.

Locate grid square 4466 on your LEAVENWORTH map. What is the name of the church located in this grid square? ________________ ________________

(355576 (If you did not write this number correctly, turn back to frame 13 and review the steps)) (29)

FRAME 30.

Any scale or rule that divides the side of a grid square into tenths can be used to read 6-digit coordinates. Look at the plastic training aid provided with this text. Find the two L-shaped scales divided into tenths. These scales are used to read 6-digit ______________.

Set 2-2. RELATING POINT LOCATION TO THE MILITARY GRID REFERENCE SYSTEM

(bottom-up) (43)

FRAME 44. INFORMATION FRAME.

In the following frames, you will learn how your LEAVENWORTH map fits into the total military mapping program — the Military Grid Reference System. Using the knowledge of the Military Grid Reference System, you will then learn how to report your location on the LEAVENWORTH map to a distant headquarters or unit.

(Go on to next frame) (2)

FRAME 3.

Find the numbers for the grid lines on your LEAVENWORTH map. The line numbers are printed in the map margin and also in heavy, black type in the middle of the map itself. Reading from left to right, the eastings are numbered from ________ to 49.

(Flintlock Church) (16)

FRAME 17.

On your LEAVENWORTH map, what school is located in grid square 4155?

__________________.

(coordinates) (30)

FRAME 31.

Find grid square 3847 on your LEAVENWORTH map. Place the correct L-shaped scale of your plastic protractor exactly over the lines which form the grid square. Which of the two scales on the plastic protractor fits exactly?

a. 1:25,000

b. 1:50,000

(Go on to next frame) (44)

FRAME 45.

The standard Military Grid Reference System divides the earth into zones and tiers (see Panel 2-1). The zone reading "to the right" is in numbers, 1 to 60, and the tier reading "up" is in letters, A to Z (without the I and O). The combination of zone number and tier letter is called the GRID ZONE DESIGNATION. The grid reference box on the LEAVENWORTH map (center of bottom margin) explains the GRID ZONE DESIGNATION for the location of the map. What is the GRID ZONE DESIGNATION for the Leavenworth map?

a. 403622

b. UP

c. 15S

(28) (3)

FRAME 4.

Reading up from the bottom of your LEAVENWORTH map in the right margin, what are the numbers of the northings?

a. 5 to 41 b. 46 to 73

(Eldorado) (17)

FRAME 18.

On your LEAVENWORTH map, what school is located in grid square 4550?

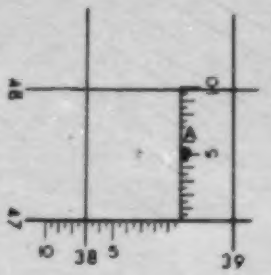
____

(b. 1:50,000) (31)

FRAME 32.

The sketch shows how to place the scale for the left-to-right reading at the imaginary line inside the grid square. Notice that point A is 7/10 of the distance from line 38 to 39. What are the first 3 digits of the grid coordinates (left-to-right reading)?

a. 381 b. 385 c. 387



(c. 15S (Numbers to the right (column 15) and letters up (tier S) (Panel 2-1)) (45)

FRAME 46.

The grid zones are further subdivided into 100,000-meter squares identified by two letters which are also read to the right and up (see panel 2-2). The grid reference box identifies the 100,000-meter square in which the LEAVENWORTH map falls as ____________________.

(b. 46 to 73) (4)

FRAME 5.

You always begin to locate points by beginning in the lower left corner. First, you read the eastings from left to right. For the northings, you read from the bottom ____________________.

(Lanter School) (18)

FRAME 19.

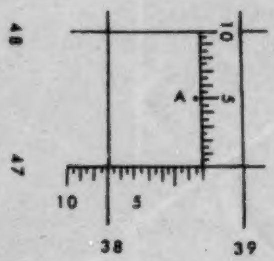
Four-digit grid coordinates locate a grid square. Six-digit coordinates pinpoint objects inside a grid square. For example, 3625 locates a square and 368254 locates a road junction inside that square. The number 8 is added as the third digit; the number 4 is added as the ____________________ digit.

(c. 387) (32)

FRAME 33.

Point A is in the same location as before. The scale is placed correctly for the bottom-up reading (last 3 digits). What are the 6-digit coordinates?

a. 387471 b. 387475 c. 387477



(UP) (46)

FRAME 47.

The outline of each of these squares is an even 100,000-meter grid line with the numbers increasing to the right and up (Panel 2-2). The left easting of the marked square UP is 300,000 meters east. What is the right easting of that square?

a. 200,000 meters east b. 300,000 meters east c. 400,000 meters east (up) (5)

FRAME 6.

Every grid square has a 4-digit number, such as 3354. The first two digits (33) stand for the correct easting; the last two digits (54) stand for the correct

____________________.

(6th) (19)

FRAME 20.

The 4-digit grid coordinates 4659 locate Platte City on your LEAVENWORTH map. The 6-digit coordinates 468597 pinpoint a cemetery in the outskirts of the town. Compare 4659 and 468597. The 46 and 59 for the grid square are still in the 6-digit coordinates. Which digits have been added?

a. 1st and 4th b. 2d and 5th c. 3d and 6th

(b. 387475) (33)

FRAME 34.

Now practice what you have learned by using the plastic scale to locate points on your LEAVENWORTH map. Find grid square 4550, in which Lanter School is located. What are the 6-digit coordinates which locate Lanter School?

a. 451507 b. 455505 c. 457501

(c. 400,000 meters east (The LEAVENWORTH map falls in the 100,000-meter square designated by the letters UP and outlined by the 300,000 and 400,000 meters east lines and 4,300,000 and 4,400,000 meters north lines)) (47)

FRAME 48.

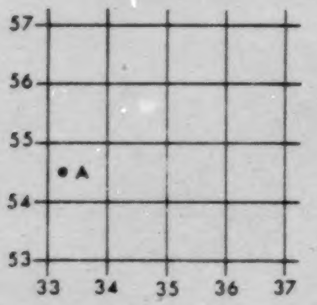
The grid line numbers $^{3}28\,^{000m}$E and $^{43}47\,^{000m}$N, in the lower left corner of your LEAVENWORTH map refer to 328,000 meters east and 4,347,000 meters north, respectively. These are the grid coordinates for the first grid lines in the ____________ ____________ corner of the map.

(northing) (6)

FRAME 7.

Every grid square number comes from the two grid lines which cross at the lower left corner of the square. Point A in the figure below is in grid square 3354. In writing the grid square number, the number of which line is written first?

a. easting b. northing



(c. 3d and 6th) (20)

FRAME 21.

The 4-digit coordinates locate the grid square. The 6-digit coordinates locate not only the grid squares but a point within the square. In the coordinates 469595, which 2 digits locate the point within the square? ____________ and ____________

(c. 457501 (If your answer was 451507, you reversed the 3d and 6th digits)) (34)

FRAME 35.

On your LEAVENWORTH map, Flintlock Church is in grid square 4466. What is its 6-digit location? ____________________

(lower left (southwest) (The coordinates are given in full in the southwest corner of military maps)) (48)

FRAME 49.

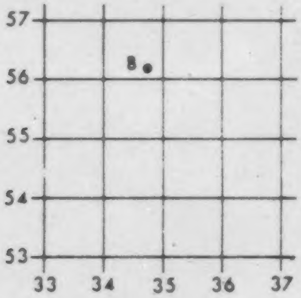
On all other grid lines, the $^{000\text{m}}$E or $^{000\text{m}}$N are not shown on the map, but are understood. The ^{3}48 in the lower right corner means ____________ meters east.

(a. easting) (7)

FRAME 8.

Determine the correct number for the grid square containing point B. Start from the lower left. The easting which goes through the lower left corner of the square is 34. Now, find the northing that goes through the lower left corner. What is the 4-digit number?

a. 3355 b. 3456 c. 3557



(3d and 6th (9,5)) (21)

FRAME 22.

The first 3 digits of 6-digit coordinates are the easting grid reading and the last 3 digits are the ______________ grid reading of the more accurate location.

(444662) (35)

FRAME 36.

Using the plastic coordinate scale find the point at 360706 on the LEAVENWORTH map. What ground feature is located there?

a. cemetery b. road junction c. lake

(348,000) (49)

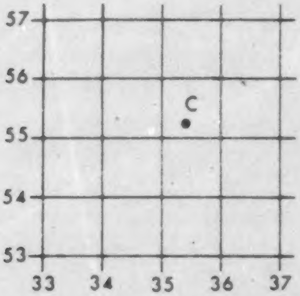
FRAME 50. INFORMATION FRAME.

When reporting your location (Hazelwood School 403622, LEAVENWORTH map) to another unit or headquarters which is outside your 100,000-meter square or in another grid zone, or both, certain procedures are necessary to properly identify your position.

(b. 3456) (8)

FRAME 9.

Remember that the grid square is identified by the eastings (vertical grid lines) and northings (horizontal grid lines) which form the lower left corner of the square. You write the number of the easting first, then the northing. The number for the grid square containing point C is ____________________.



(northing) (22)

FRAME 23.

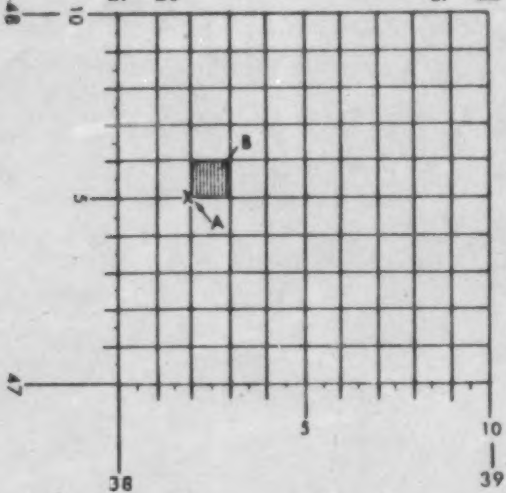
You have learned that grid coordinates with 4 digits locate a grid square. The number 4659 located Platte City on your LEAVENWORTH map. Six-digit coordinates are, as you have seen, more accurate. The two additional numbers (digits) locate a point within the ____________________ square.

(c. lake) (36)

FRAME 37.

The 4-digit coordinates locate grid square 3847. The number 382475 locates one of 100 imaginary squares at point A. If the grid were divided into 10,000 imaginary squares, how many digits would be required to pinpoint B?

a. 8 b. 10 c. 12



(Go on to next frame) (50)

FRAME 51.

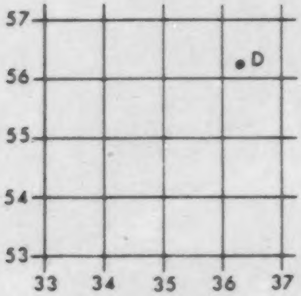
When the unit to which you are reporting your location (Hazelwood School 403622) is in the same 100,000-meter square, you report your location simply by stating the coordinates. You would report your location as ____________________.

(3555 (35 is the vertical grid line, 55 is the horizontal grid line)) (9)

FRAME 10.

Find the number of grid square in which D is located. It is in square

_____________________.



(grid) (23)

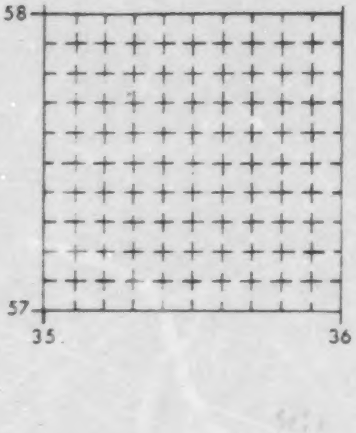
FRAME 24.

For 6-digit coordinates, the sides of the grid square are divided into tenths with imaginary lines (shown as dotted lines here). These form 100 imaginary smaller squares. What would be the **4-digit** coordinates for the grid square shown below?

a. 3557

b. 3657

c. 5735

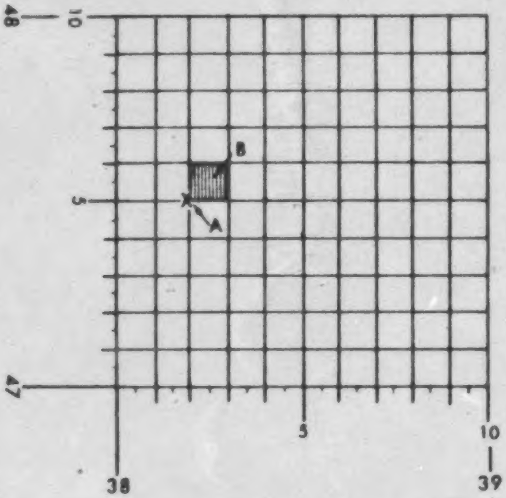


(a. 8) (37)

FRAME 38.

The 6-digit number for point A was 382475. The 8-digit coordinates for point B are 38274757. Which digits were added?

a. 1st and 8th   b. 3d and 6th   c. 4th and 8th



(403622) (51)

FRAME 52.

In reporting your location to a unit or headquarters outside your UP 100,000-meter square but in the same grid zone, the 6-digit grid coordinates alone could refer to any one of several points in other 100,000-meter squares. To avoid misidentification, you identify your square by placing the letters ______________ preceding the coordinates.

(3656) (10)

FRAME 11.

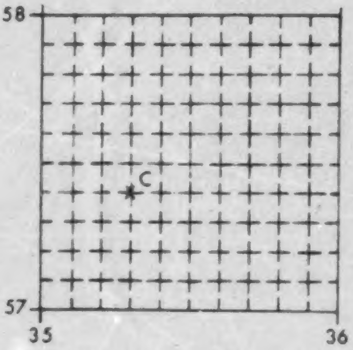
The square, you have seen, has each time been identified by giving the number of the easting first, then the northing. In grid square 3556, 35 would be the easting and 56 the ________________.

(a. 3557 — lower left corner, easting (vertical) first) (24)

FRAME 25.

In grid square 3557, the 6-digit coordinates for point C are 353574. The third digit means that point C is 3/10 of the distance from easting 35 to easting 36. The sixth digit means that point C is 4/10 of the distance from northing 57 to northing

________________.



(c. 4th and 8th) (38)

FRAME 39.

No matter how many digits are used, the first half of the coordinate numbers locates the easting (left-to-right). The last half locates the northing (bottom-up). The total number of digits in any set of coordinates is always ________________.

a. odd

b. even

(UP) (52)

FRAME 53.

In reporting your location in Hazelwood School to a headquarters outside your 100,000-meter square, but in the same zone, you would state your location to be ________________.

(northing) (11)

FRAME 12.

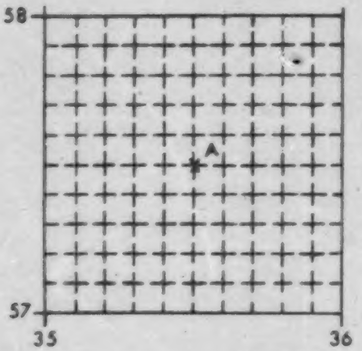
Grid square numbers are called grid coordinates. In writing grid coordinates, you write the number of the easting first and the number of the ______________ next.

---

(58) (25)

FRAME 26.

Note that point A is in the center of grid square 3557. That is, A is 5/10 of the distance from easting 35 to easting 36 and from northing 57 to northing 58. The 6-digit coordinates would be 35 _________ 57 _________.



(b. even) (39)

FRAME 40.

The 6-digit coordinates locate points within 100 meters of their actual ground location on the LEAVENWORTH map. The 8-digit coordinates further divide each 100 meters into 10-meter units. What is the accuracy of the 8-digit coordinates?

a. 10 meters b. 20 meters c. 50 meters

(UP403622 (See grid reference box once again)) (53)

FRAME 54.

Hazelwood School, the sample point in the grid reference box, can be located in the 100,000-meter square in two ways: either by 340,300 meters east by 4,362,200 meters north or by the letters and grid coordinates ________________.

(northing) (12)

FRAME 13.

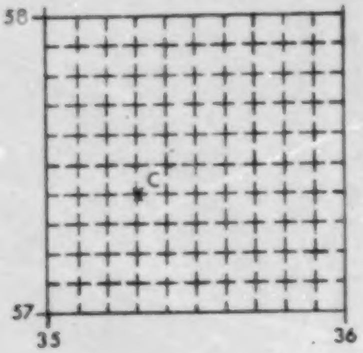
The numbers of the eastings and northings which identify a grid square are called the grid __________________.

(355575) (26)

FRAME 27.

You learned that point C was on imaginary easting 353. The last 3 numbers in 6-digit coordinates locate the imaginary northing. What would be the correct 6-digit coordinates for point C?

a. 353572 b. 353574 c. 353576



(10 meters) (40)

FRAME 41.

The 8-digit coordinates locate points to within 10 meters on the ground, which is closer than average user requirements and map accuracy warrants. The center of Terminal Bridge on your LEAVENWORTH map is 35655351. This number should locate the point to within ____________ meters of the exact center of the bridge.

(UP403622 (This is the shorter way of referring to the coordinates in the correct 100,000-meter square)) (54)

FRAME 55.

Now let us assume that you must report your location (Hazelwood School) to higher headquarters, which is not only outside your 100,000-meter square but also in another grid zone. In this case you would have to include the grid zone designation, the 100,000-meter square identification, and the coordinates of Hazelwood School. Therefore, in reporting your location to this higher headquarters you would state your location as ________________.

(coordinates) (13)

FRAME 14.

Practice with the LEAVENWORTH map. Find Terminal Bridge, which crosses the Missouri River near the center of the city of Leavenworth. What are the **grid coordinates** of the square in which Terminal Bridge is located?

a. 3553 b. 5335

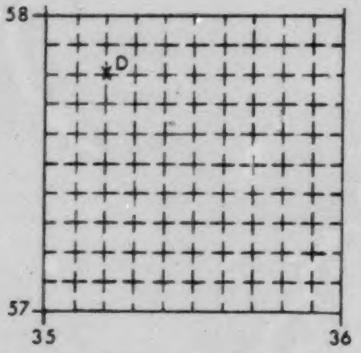
Turn back to bottom of page 2-1 for frame 15

(b. 353574 (Point C is 4/10 of the distance up from line 57)) (27)

FRAME 28.

You combine the 3-digit "right" reading with the 3-digit "up" reading for 6-digit coordinates. What are the 6-digit grid coordinates of point D?

a. 352578 b. 353574 c. 358572



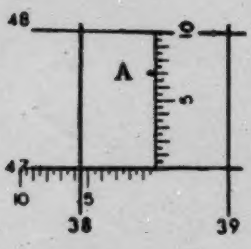
Turn back to top of page 2-2 for frame 29

(10) (41)

FRAME 42.

You must estimate the position of the point between divisions on your coordinate scale to determine the 4th and 8th digits. For the left-to-right reading to locate point A, you know that the first three numbers are 385. Point A is halfway (5/10) between the 500- and 600-meter division. What would the first four numbers be?

a. 3850 b. 3855 c. 3857



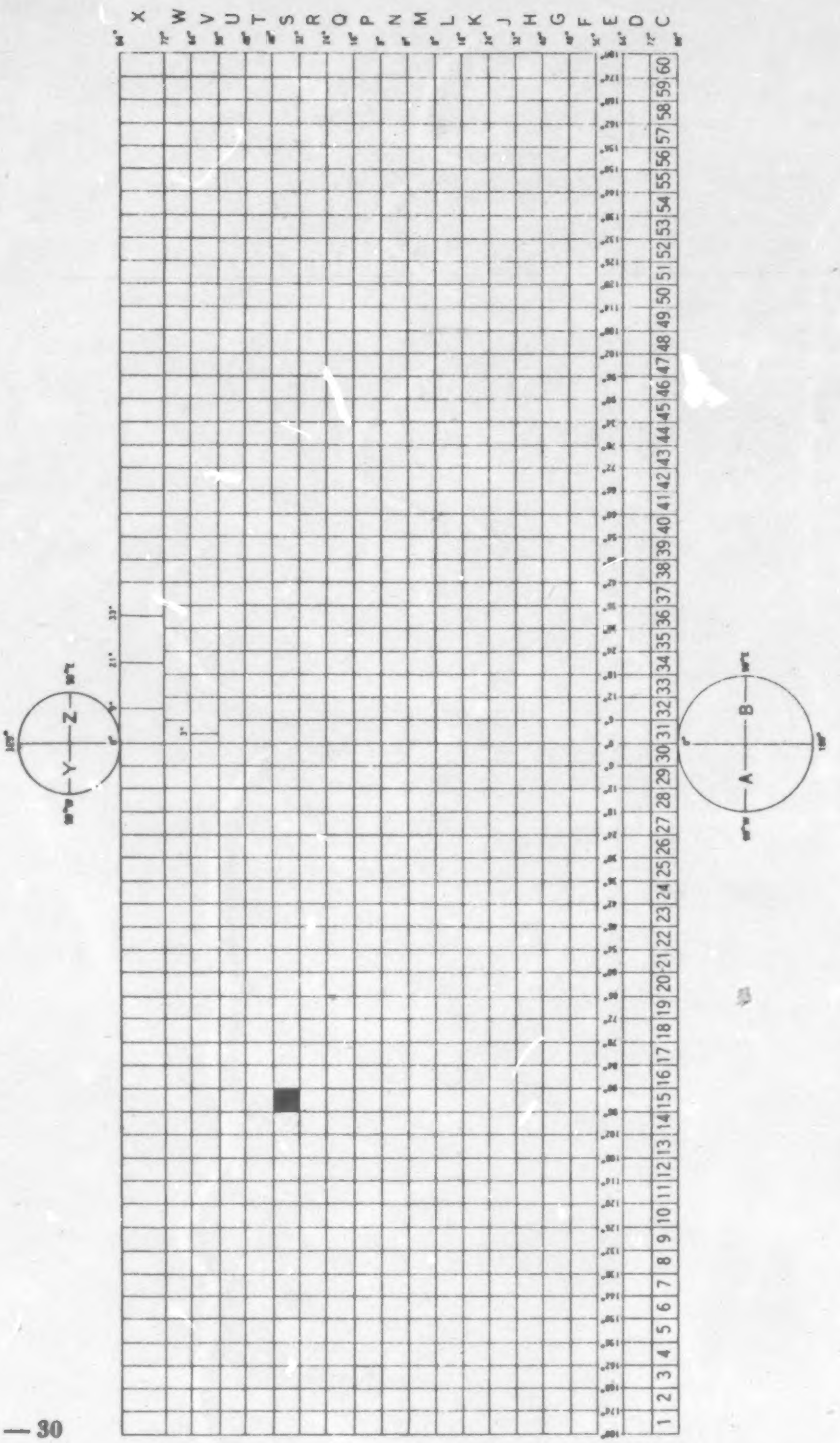
Turn back to bottom of page 2-2 for frame 43

(15SUP403622) (55)

FRAME 56. REVIEW FRAME.

To review, the military grid system applies to the entire world and is divided into grid zones, further divided into 100,000-meter squares. The LEAVENWORTH map is in Grid Zone 15, Tier S, and in 100,000-meter square UP. See Panels 2-3 and 2-4.

END OF FRAMES FOR PART II


X
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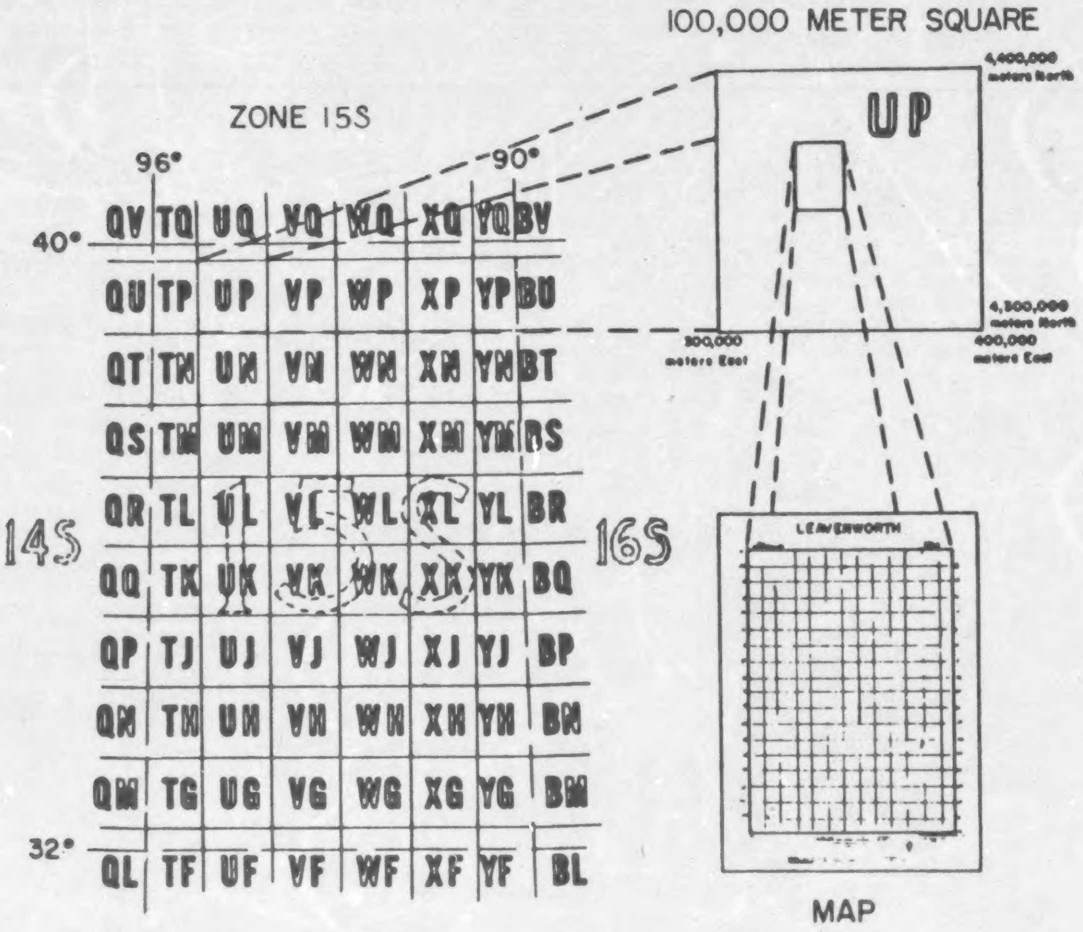
59
60
Y
Z
A
B

Military Grid Reference System. (Fort Leavenworth map is within grid zone designation 15S.) (Black square).

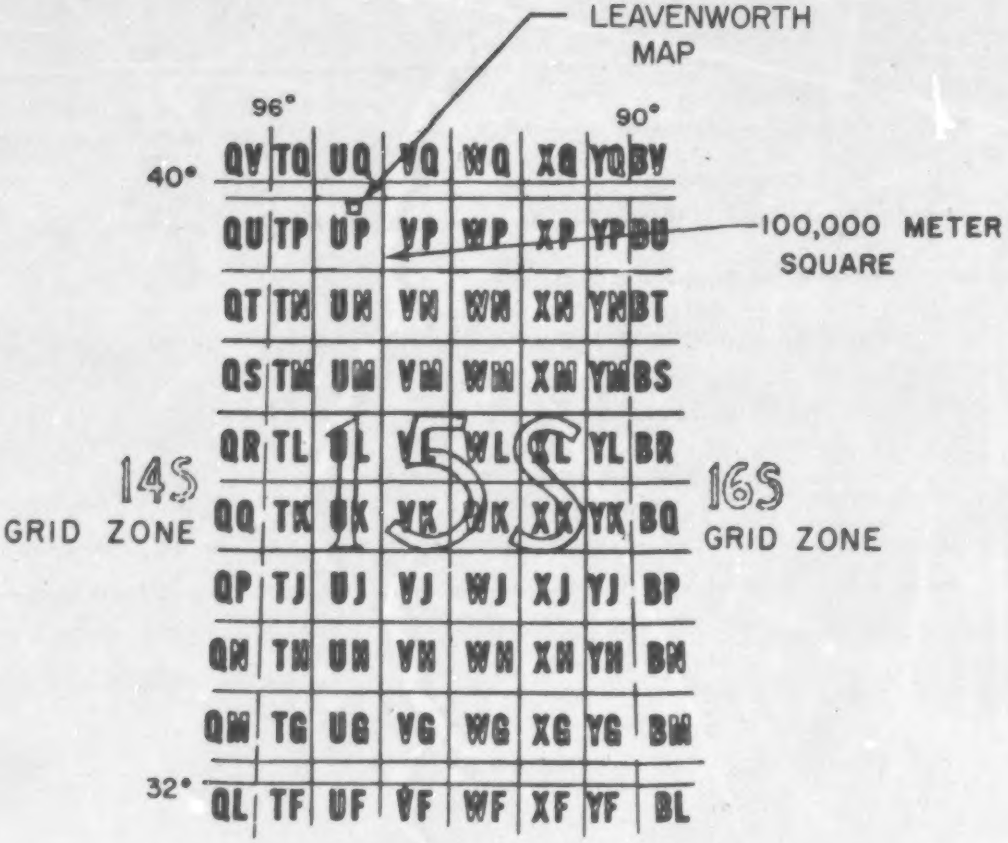
PANEL 2-2

MAP LOCATION WITHIN GRID ZONE


100,000 METER SQUARE
4,400,000 meters North
UP
4,300,000 meters North
300,000 meters East
400,000 meters East
ZONE 15S
96°
90°
40°
QV TQ UQ VQ WQ XQ YQ BV
QU TP UP VP WP XP YP BU
QT TN UN VN WN XN YN BT
QS TM UM VM WM XM YM BS
QR TL UL VL WL XL YL BR
14S
16S
QQ TK UK VK WK XK YK BQ
QP TJ UJ VJ WJ XJ YJ BP
QN TH UH VH WH XH YH BN
QM TG UG VG WG XG YG BM
32°
QL TF UF VF WF XF YF BL
LEAVENWORTH
MAP

PANEL 2-3

MAP LOCATION WITHIN GRID ZONE (LEAVENWORTH MAP SHOWN IN UP 100,000-METER SQUARE)


LEAVENWORTH MAP
96°
90°
40°
QV TQ UQ VQ WQ XQ YQ BV
QU TP UP VP WP XP YP BU
100,000 METER SQUARE
QT TN UN VN WN XN YN BT
QS TM UM VM WM XM YM BS
QR TL UL VL WL XL YL BR
14S
GRID ZONE
15S
16S
GRID ZONE
QQ TK UK VK WK XK YK BQ
QP TJ UJ VJ WJ XJ YJ BP
QN TH UH VH WH XH YH BN
QM TG UG VG WG XG YG BM
32°
QL TF UF VF WF XF YF BL

GRID ZONE DESIGNATION

PANEL 2-4

SUMMARY OF MILITARY GRID REFERENCE SYSTEM

a. Military Grid Reference System.

You have seen that a Military Grid Reference System applies to the entire world.

b. Grid Zones.

The system is composed of vertical columns or grid zones identified by numbers, and horizontal tiers, identified by letters. The combination of numbers and letters, for example 18M, 15S, etc., is called the Grid Zone Designation.

c. 100,000-Meter Square Identification.

Each grid zone is, in turn, divided into 100,000-meter squares, identified by pairs of letters, such as TP, UP, VP, etc.

d. Map Areas.

The area of the Fort Leavenworth map is approximately 21,000 meters East-West by 27,000 meters North-South. A map may fall entirely within one 100,000-meter square, or it may contain portions of more than one 100,000-meter square. The grid reference box in the lower margin of each map sheet tells you the correct 100,000 meter identification for that sheet, and the correct grid zone designation.

PART III

DISTANCE

Set 3-1. DETERMINING GROUND DISTANCE BY REPRESENTATIVE FRACTIONS (RF)

FRAME 1.

Any specific distance on a map represents a specific distance on the ground. For example, 1 inch on your LEAVENWORTH map (map distance) equals 50,000 inches on the ground (ground distance). The relation of these two distances is called the map's **scale** or **representative fraction (RF)**. The scale of a map is the relation between map distance and ____________________ distance.

Set 3-2. SCALES OF MILITARY MAPS

(a. 2.5. 250,000 centimeters equals 2,500 meters or 2.5 km. 250,000 cm ÷ 100,000 cm per kilometer = 2.5 kilometers.) (8)

FRAME 9.

In previous frames, you have learned the purpose and use of map scale.

Military maps are classified according to scale as follows:

small — $\frac{1}{600{,}000}$ or smaller

medium — between $\frac{1}{75{,}000}$ and $\frac{1}{600{,}000}$

large — $\frac{1}{75{,}000}$ or larger

The military map of a scale $\frac{1}{600{,}000}$ or smaller is classified as ______________

____________________.

(tick marks) (16)

FRAME 17.

To determine the distance in miles (and tenths), you move down to the bar scale marked in ________________.

(c. 5900. The distance (on the bar scale) measures about 1970 yards, and converts (3 × 1970) to about 5900 feet.) (24)

FRAME 25.

You often have to measure the length of curving section of road. To do this, you "straighten out" the curve by ticking off short straight segments in sequence on the edge of a sheet of paper (Panel 3-7). The equivalent straight line distance of the curve can now be measured on the bar scale. For example, a sharp curve will require which type of adjustment?

a. shorter segments b. longer segments c. varied lengths of segments (ground) (1)

FRAME 2.

The map scale or RF may be written as a ratio, 1:50,000, or as a fraction, $\frac{1 \text{ (map)}}{50{,}000 \text{ (ground)}}$. Both mean the same thing. How is the scale written in the marginal information of the Leavenworth map?

a. 1:50,000

b. $\frac{1}{50{,}000}$

(small scale) (9)

FRAME 10.

The larger the denominator of the RF, the smaller will be the scale. Why? Because $\frac{1}{600{,}000}$ is a smaller value than $\frac{1}{75{,}000}$, just as ⅛ of a pie is a smaller piece than ¼ or ½. Which of the RF's is the smallest scale?

a. $\frac{1}{25{,}000}$,

b. $\frac{1}{50{,}000}$

c. $\frac{1}{100{,}000}$

(miles) (17)

FRAME 18.

However, you see that the distance between the two ticks is longer than the bar scale. Therefore, place this right tick on the right end of the scale (at the 3-mile point). Mark the left end of the bar scale (marked with a 1) on the paper's edge. You have now marked ________ miles of the distance.

(a. shorter segments. Each segment should stay within the road limits. A too long segment will result in a too short distance.) (25)

FRAME 26.

On your LEAVENWORTH map locate the junction of routes 45 and 92 (388588). Route 45 curves from this point until it reaches the north-south road out of Weston (364652). Using the curved-road measuring technique, what is the measured road distance, in kilometers?

a. 6.0 b. 7.2 c. 8.3

(a. 1:50,000. Other maps may use the fraction.) (2)

FRAME 3.

If a map were drawn with a scale of 1:2000, how many inches on the ground would 2 inches on the map represent? On a map of the same scale, how many centimeters on the ground would 2 centimeters on the map represent?

Inches: a. 1000 b. 2000 c. 4000

Centimeters: a. 1000 b. 2000 c. 4000

(c. $\frac{1}{100{,}000}$. This is the smallest fraction in the group) (10)

FRAME 11.

You learned that 5 centimeters of a map distance equals 2.5 km of ground distance at a scale of $\frac{1}{50{,}000}$ (large-scale). If you measured 5 centimeters (map distance) between two towns on a small-scale map of $\frac{1}{1{,}000{,}000}$, what would be the ground distance in kilometers?

a. 25 b. 50 c. 75

(4) (18)

FRAME 19.

Next slide this new mark to the right until it falls on the mile graduation that permits the original left tick to fall within the tenths of a mile scale. Read the value. It will be ________ miles.

Set 3-4. DETERMINING UNKNOWN SCALE OF MAP OR PHOTO

(c. 8.3) (26)

FRAME 27.

You may find maps, sketches, or photographs whose scale is unknown. You can determine the scale if you can identify objects or features with known measurable distances. For example, your map of unknown scale shows a church located close to a crossroad near your unit. The map distance is ½ inch. You then measure the actual ground distance between the crossroads and church and find it to be 100 yards (3600 inches). Therefore, ½ inch map distance equals 3600 inches ground distance. What is the RF of the map?

a. $\frac{1}{3600}$ b. $\frac{1}{7200}$ c. $\frac{1}{12{,}500}$

(c. 4000 inches, 4000 centimeters) (3)

FRAME 4.

You notice that **inches** or **centimeters** on the map represent **inches** or **centimeters** on the ground. Sometimes map readers make the mistake of using one measure for map distance (centimeters or inches) and a different measure for ground distance (meters or yards). Panel 3-1 tells you how to convert from one unit to another. If a map distance is measured in centimeters, the ground distance will be measured in ________________.

a. kilometers b. meters c. centimeters

(b. 50. 5cm × 1,000,000 = 5,000,000cm = 50,000 meters = 50 km.) (11)

FRAME 12.

The standard Army map scales are:

small — $\frac{1}{1,000,000}$

medium — $\frac{1}{250,000}$

large — $\frac{1}{50,000}$

What scale would be used mostly for strategic studies (covering large areas) by commanders of large units?

a. small b. medium c. large

(2.2) (19)

FRAME 20.

The distance (from Iatan to Weston) required is the sum of the 4 miles you first ticked off and the reading from the last frame (2.2 miles). The distance along the railroad between the two locations is ________.

(b. $\frac{1}{7200}$. $RF = \frac{MD}{GD} = \frac{\frac{1}{2}\text{ inch}}{3600\text{ inches}}$ or $RF = \frac{1}{7200}$) (27)

FRAME 28.

$\frac{\text{Map distance}}{\text{Ground distance}}$, measured in the same units, will always give you the ________________ of a map or photo.

(c. centimeters) (4)

FRAME 5.

RF stands for a fraction or $\frac{\text{map distance}}{\text{ground distance}}$ or $\frac{\text{MD}}{\text{GD}}$ (see Panel 3-2). Thus, $\text{RF} = \frac{\text{MD}}{\text{GD}} = \frac{\text{1 centimeter}}{\text{50,000 centimeters}}$ or $\frac{\text{1 inch}}{\text{50,000 inches}}$. Both distances must be in the same units of measurement. Which of the following is correctly written for a map scale of 1:25,000?

a. $\text{RF} = \frac{1}{25{,}000}$ b. $\text{RF} = \frac{\text{1 in}}{\text{25,000 ft}}$ c. $\text{RF} = \frac{\text{1 in}}{\text{25,000 yds}}$

Set 3-3. DETERMINING GROUND DISTANCE BY BAR SCALE

(a. small. The small-scale map $\left(\frac{1}{1{,}000{,}000}\right)$ would cover the largest area of ground on each map sheet.) (12)

FRAME 13.

Bar scales (see Panel 3-4) are printed on military maps to provide another way to determine ground distances from the map information. The **bar scale** is the ruler, graduated in miles, meters, and yards, which appears in the bottom margin. The bar scale shows how much ground distance is represented by certain lengths of map distance. How many meters of ground distance does the complete meter scale represent?

a. 4000 b. 5000 c. 6000

(6.2) (20)

FRAME 21.

For even longer distances in miles, you would first tick mark as many 4-mile steps as possible on the edge of your paper. Then, to measure the additional distance to tenths of a mile, you would as before, slide your paper to the right to the mile mark on the bar scale (0, 1, 2, 3) which causes the remaining distance to be measured to fall within the _________ of a mile divisions of the bar scale. Panel 3-6 tells you how to determine distances to points that fall outside your map sheet.

(Scale) (28)

FRAME 29.

You can also determine the scale of a map or photograph of unknown scale by comparing it with a map of the same area whose scale is known. Remember the $\frac{1}{50,000}$ scale map where the map distance between two road intersections was 5 centimeters? The actual ground distance between the two intersections would be 5cm × 50,000 or 250,000cm. If you locate the same road intersections on the map of unknown scale and find them to be 20cm apart, you can use the ground distance obtained from the $\frac{1}{50,000}$ scale map in the scale formula $\frac{MD}{GD} = RF$ to find the scale of the unknown map. What do you determine this RF to be?

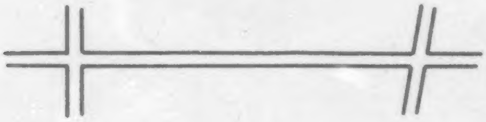
a. $\frac{1}{12,500}$ b. $\frac{1}{25,000}$ c. $\frac{1}{200,000}$

(a. $RF = \frac{1}{25{,}000}$. In using RF's, remember that the units must be the same.) (5)

FRAME 6.

In using the scale or RF to find the ground distance (GD), you first measure the map distance (MD). The sketch shows two road junctions as they appear on a map. If your protractor has a centimeter scale, use it to measure the distance. If you do not have a centimeter scale, Panel 3-3 tells you how to use your map to obtain centimeter measurements. What is the map distance, in centimeters, between the road junctions?

a. 3 b. 4 c. 5



(c. 6000. The zero of the bar scale is not at the left end. From the zero, there are 5000 meters (graduated in 1000-meter units) to the right, and another 1000 meters (graduated in 100-meter units) to the left. The combined length is 6000 meters.) (13)

FRAME 14.

You normally use the bar scale by "taking the measured map distance to the scale". One good way is to tick mark the map distance on the edge of a sheet of paper. The measurement is moved and placed so that the right end (tick) falls on an even reading and the left end (tick) falls in the subdivided section to the left of the zero. The map distance shown in Panel 3-5 equals how many meters of ground distance?

a. 1300 b. 1405 c. 1520

(10ths) (21)

FRAME 22.

The bar scales are handy rulers which help you to convert map measurements to actual ground distance. Remember to use the bar scale which gives you the desired units of ground measurement. If you want a ground distance in kilometers, you would use the meters scale in the map margin (1000 meters = 1 kilometer). Measure one side of a grid square on your LEAVENWORTH map and take it to the meters bar scale. How long in meters, is the side of a grid square?

a. 500 b. 1000 c. 1500

$\left(\text{a. } \frac{1}{12{,}500}.\ \frac{\text{MD}}{\text{GD}} = \frac{20\text{cm}}{250{,}000\text{cm}} = \frac{1}{12{,}500}\right)$ **(29)**

FRAME 30.

The two steps of finding the ground distance and using the scale formula $\left(\text{RF} = \frac{\text{MD}}{\text{GD}}\right)$ can be combined into one as follows:

Use the measured distance on the map of unknown scale (UMD) as the numerator, and the measured distance on the map of known scale (KMD) as the denominator, and multiply this fraction by the RF of the known map: $\frac{\text{UMD}}{\text{KMD}}$ (RF).

Using this formula, find the RF of a map of unknown scale on which the distance between two points is measured as 2 inches, if the same distance on a 1:50,000 scale map is measured as 4 inches.

(c. 5) (6)

FRAME 7.

You have measured the map distance as 5 centimeters. If the map scale is 1:50,000, then the ground distance is 50,000 times as long as the map distance. What is the ground distance, in centimeters, between the road junctions?

a. 2,500 b. 25,000 c. 250,000

(c. 1520. The right tick is placed on an even meter mark (1000 in this case) and the left end is among the subdivided section (in 100 meters). The total distance is 1520 meters.) (14)

FRAME 15.

Use your map scale (1:50,000 on your Protractor and Map Scales) to locate the road junctions at 404638 and 405678 on your LEAVENWORTH map. Using the tick mark method explained in the previous frame, what is the distance, in yards, between the two junctions?

a. 4400 b. 5500 c. 6600

(b. 1000. The grid squares on large-scale military maps are all drawn 1000 meters square.) (22)

FRAME 23.

The grid squares on the LEAVENWORTH map are 1000 meters, or 1 kilometer, long. You can estimate distance quickly using the 1 kilometer squares as "measuring sticks". What is the approximate straight line distance, in kilometers, from Horseshoe Lake (4247) to Roberts Lake (4556)?

a. 3 b. 5 c. 10

Set 3-5. DISTANCE AND TRAVEL TIME

$$\left(\frac{1}{100{,}000}.\ \frac{\text{UMD}}{\text{KMD}}\ (\text{RF}) = \frac{2''}{4''} \times \frac{1}{50{,}000} = \frac{2''}{200{,}000''} = \frac{1}{100{,}000}\right)\ (30)$$

FRAME 31.

You often have to find the time it will take you to travel to a new location. How long it will take you depends on the ground distance (D) to the new location and how fast you travel (r). So, ground distance and rate of ________________ are the two factors you must know.

(c. 250,000. The map distance is 5 centimeters and the ground distance is 50,000 times that or 250,000 centimeters. Watch the units in this multiplication.) (7)

FRAME 8.

The ground distance between the intersections is 250,000 centimeters, but is usually given as **meters** or **kilometers**. Therefore, you convert the centimeters to the desired unit. To convert centimeters to meters, divide by 100; to convert centimeters to kilometers, divide by 100,000. What is the ground distance, in kilometers, between the road intersections?

a. 2.5
b. 25
c. 50

Turn back to bottom of page 3-1 for frame 9

(a. 4400. Place the right end tick on the 4000 *yard* mark of the bar scale and the left end tick will fall on the 400 mark to the left of zero (4000 + 400 = 4400)) (15)

FRAME 16.

To measure longer distances, the same procedure is used, but the measurement is made in steps. You have to determine the distance along the railroad from the road crossing at Iatan (293711) to the road crossing below Weston (361637). You will again use ________ ________ along the edge of the paper to mark the distance between these two locations.

Turn back to top of page 3-2 for frame 17

(c. 10. You can count ten 1-km squares between the two lakes.) (23)

FRAME 24.

Airport runway lengths are often given in feet. You make the measurement using the YARDS bar scale and convert the distance to feet. (3 feet = 1 yard) On the LEAVENWORTH map, what is the length, in feet, of the **longer** runway at Sherman Air Force Base?

a. 5000　　b. 5400　　c. 5900

Turn back to bottom of page 3-2 for frame 25

(speed or movement) (31)

FRAME 32.

In order to find the time it will take you to **travel a** certain **distance,** you **divide** the ground **distance** by the **rate of movement.** So if you have to travel 10 miles and you move at the rate of 5 miles per hour, you would **divide** 10 by _________ to get the time required to go the 10 miles. You find the time to be _________ hours.

(5, 2) (32)

FRAME 33. INFORMATION FRAME.

In the same way, you can find the total distance (D) traveled in a given time if you muitiply the rate of speed (r) and the time (t). You can also find the rate of speed (r) by dividing the total distance (D) by the time (t). If you know any two factors, you can find the third. The three formulas are:

1. To find distance: $D = rt$
2. To find speed: $r = \frac{D}{t}$
3. To find time: $t = \frac{D}{r}$

END OF FRAMES FOR PART III

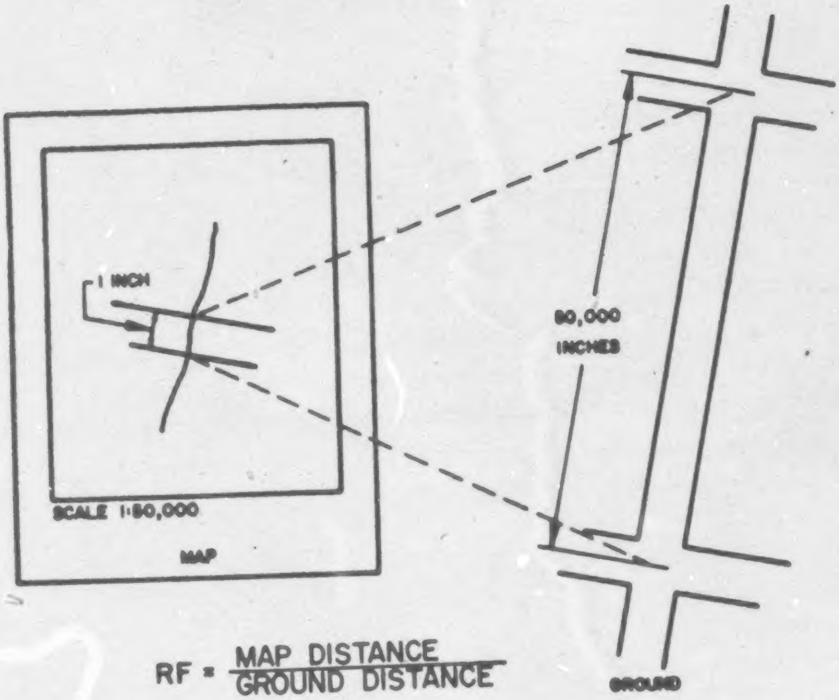
PANEL 3-1

CONVERSION FACTORS

ONE	INCHES	FEET	YARDS	STATUTE MILES	CM	M	KM
INCH	1.0	0.0833	0.0277	-------	2.54	0.0254	-------
FOOT	12.0	1.0	0.333	-------	30.48	0.3048	0.0003
YARD	36.0	3.0	1.0	0.00056	91.44	0.9144	0.0009
STATUTE MILE	63360.0	5280.0	1760.0	1.0	160930.0	1609.0	1.6093
CENTIMETER	0.3937	0.0328	0.0109	-------	1.0	0.01	-------
METER	39.37	3.2808	1.0936	0.0006	100.0	1.0	0.001
KILOMETER	39370.0	3281.0	1094.0	0.6214	100000.0	1000.0	1.0

To convert a measurement from a unit shown in the 1st column to any other unit shown in table, multiply by the factor shown in column under desired unit.

PANEL 3-2


1 INCH
SCALE 1:50,000
MAP
50,000
INCHES
GROUND

$$RF = \frac{\text{MAP DISTANCE}}{\text{GROUND DISTANCE}}$$

PANEL 3-3

USING YOUR 1:50,000 SCALE MAP TO MEASURE CENTIMETERS

If you need to measure map or photograph distances in centimeters, but do not have a centimeter scale, you can make use of the following standard relationships on your map to obtain the needed measurements.

a. The grid lines on your 1:50,000 scale map are spaced exactly 2 centimeters apart, because they represent 1000 meters ground distance at 1:50,000 scale. A linear distance may be measured along any grid line, either horizontal or vertical. The grid lines perpendicular to this line cross it at 2-cm intervals.

b. The 1000-meter divisions of the primary part of the meters bar scale in the map margin are spaced 2 cm apart, since they also represent 1000 meters at 1:50,000 scale.

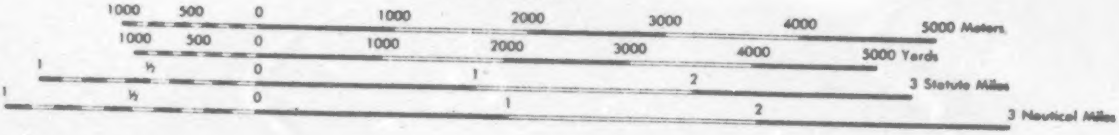
c. For small measurements, less than 2 cm in length, the extension scale to the left of the zero on the meters bar scale is divided into 100-meter segments, each of which is .2 cm long.

d. For greater precision, the 1:50,000 grid coordinate scale on your protractor, also 2 cm on each side, is divided into tenths of a centimeter (10 millimeters).

PANEL 3-4

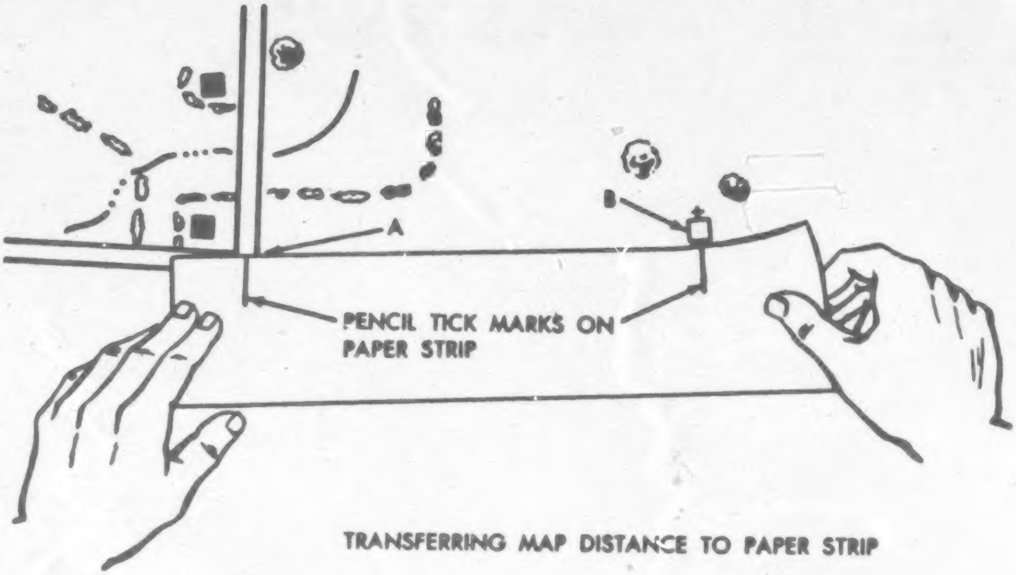
BAR SCALES

Scale 1:50,000

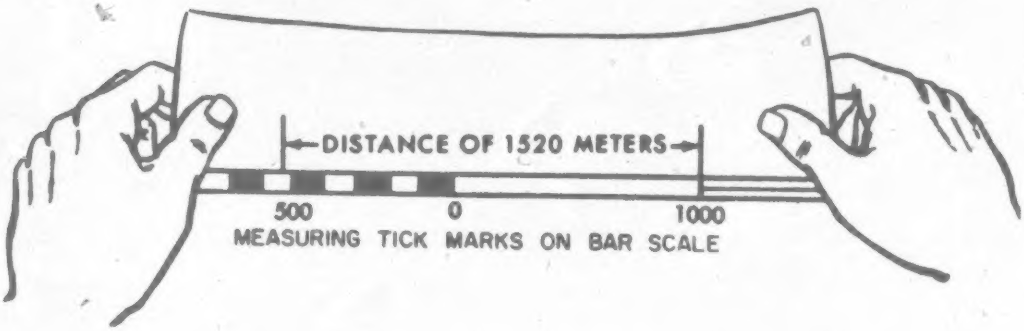

1000 500 0 1000 2000 3000 4000 5000 Meters
1000 500 0 1000 2000 3000 4000 5000 Yards
1 ½ 0 1 2 3 Statute Miles
1 ½ 0 1 2 3 Nautical Miles

PANEL 3-5

TAKING MEASURED MAP DISTANCE TO THE SCALE


A
B
PENCIL TICK MARKS ON PAPER STRIP

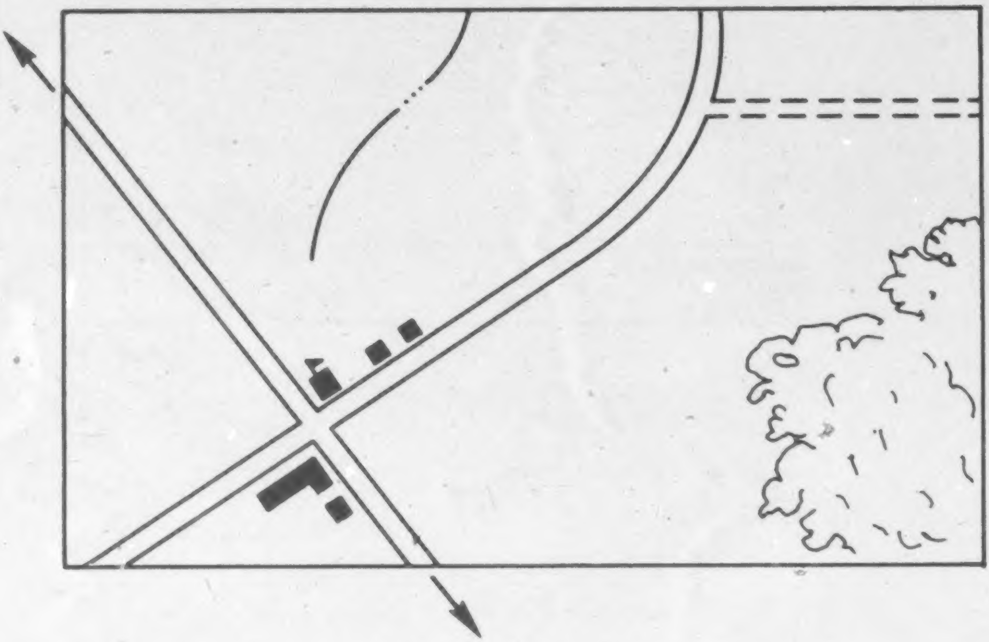
TRANSFERRING MAP DISTANCE TO PAPER STRIP


DISTANCE OF 1520 METERS
500
0
1000

MEASURING TICK MARKS ON BAR SCALE

PANEL 3-6

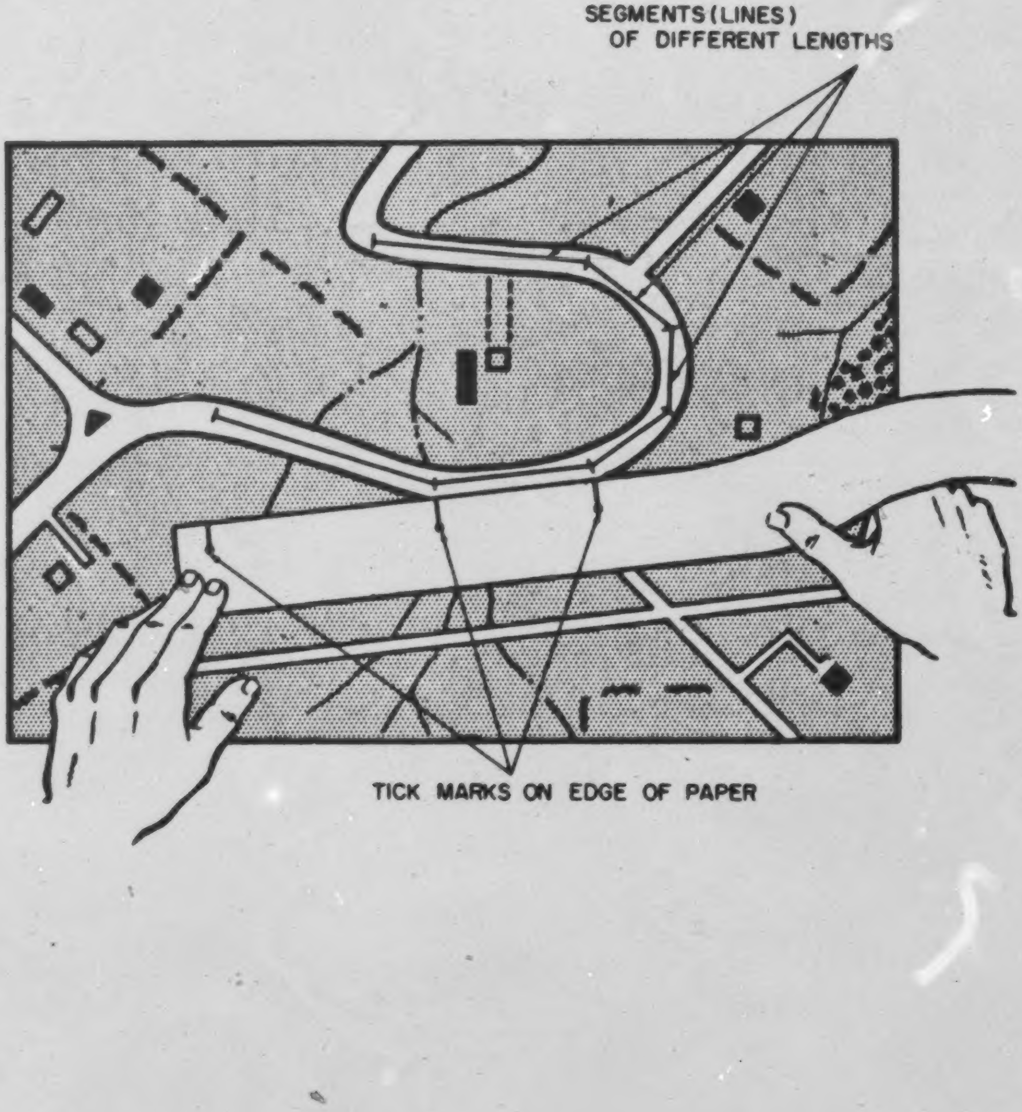
MEASURING TO POINTS OUTSIDE MAP


CENTERVILLE 6.2 MI.
JONES CORNERS 1.2 MI.
CHICAGO 25 MI.

Distances shown outside map margin represent distance from edge of map to destination or destinations indicated. Add this distance to measured map distance to find total distance to destination outside map.

PANEL 3-7

"TICKING OFF" STRAIGHT SEGMENTS TO MEASURE LENGTH OF CURVE


SEGMENTS (LINES) OF DIFFERENT LENGTHS
TICK MARKS ON EDGE OF PAPER

PART IV

DIRECTION

Set 4-1. DIRECTION—POINTS OF THE COMPASS

FRAME 1.

The four principal points of the compass are north, south, east, and west. The four principal **directions** are, therefore, north, south, east, and ____________.

(180°) (30)

FRAME 31.

To obtain a back azimuth from an azimuth, **(add) (subtract)** 180° if the azimuth is 180° or less.

(direction) (60)

FRAME 61.

If you don't know the direction of a linear feature, such as a straight road or railroad, you need at least ________________ additional prominent feature to establish the direction and orient the map.

(112° 30′. (Compass readings provide magnetic azimuth; therefore, for the Leavenworth map, grid azimuth = magnetic plus G-M angle. See note adjacent to declination diagram.))

(90)

FRAME 91.

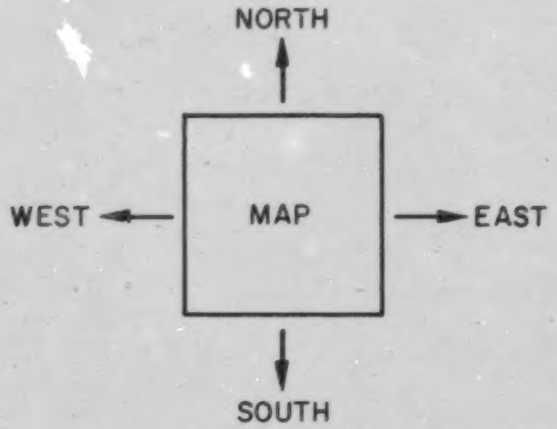
Refer to your LEAVENWORTH map. You are standing in the road junction at coordinates 307578 and observe six radio towers in grid square 3258. What is the magnetic azimuth of a line of sight from your position to the center radio tower at 32855860? (select one response)

a. 61° 0′ b. 70° 30′ c. 80° 0′

(west) (1)

FRAME 2.

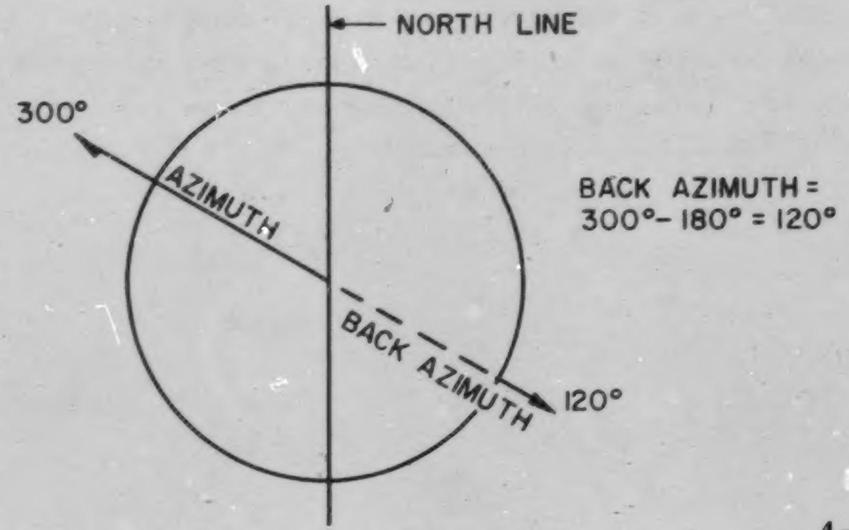
As you know, from your use of other maps (such as an automobile road map) the top of the map is normally north, the right hand margin is to the east, the left hand margin to the west, and the bottom of the map is to the south. The top of the map is normally to the north, to the right is ______________, to the left is ______________, and at the bottom of the map is ______________.


NORTH
WEST
MAP
EAST
SOUTH

(add) (31)

FRAME 32.

Study the figure below. In this case, back azimuth is determined by **(adding)** **(subtracting)** 180°. Back azimuth is simply the opposite direction of the azimuth.


NORTH LINE
300°
AZIMUTH
BACK AZIMUTH =
300°- 180° = 120°
BACK AZIMUTH
120°

(one) (61)

FRAME 62.

If you cannot positively identify the necessary features on both ground and map, you may orient your map by determining the direction of ______________ ______________.

(a. 61° 0′ (The grid azimuth is 70° 30′. Therefore the G-M angle is subtracted, or the magnetic azimuth = 70° 30′ - 9° 30′ = 61°) (91)

Set 4-10. INTERSECTION

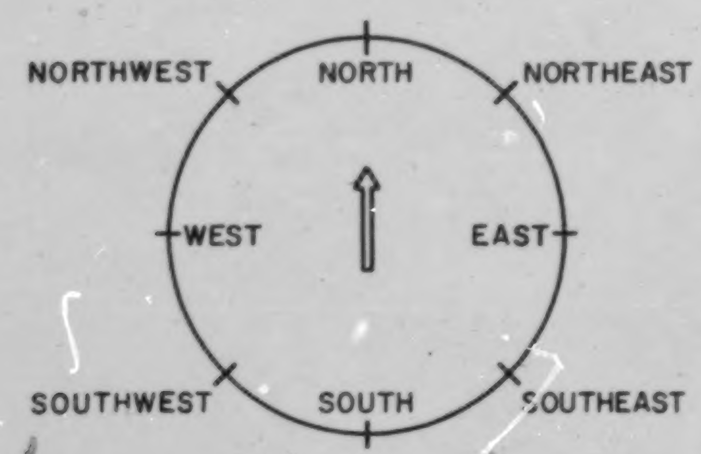
FRAME 92. INFORMATION FRAME.

INTERSECTION is a method by which you can determine the location of an unmapped enemy gun, defensive position, etc., which you can see on the ground, by plotting intersecting azimuths on a map. Accuracy in determining the location depends, in part, on the sharpness of the point of intersection of the azimuths which you draw on your map.

(east, west, south) (2)

FRAME 3.

As you can see from the simplified compass dial below, northeast lies in a direction halfway between north and east. A southwest direction would lie halfway between ________________ and ________________.


NORTHWEST
NORTH
NORTHEAST
WEST
EAST
SOUTHWEST
SOUTH
SOUTHEAST

(subtracting) (32)

FRAME 33.

To obtain a back azimuth from an azimuth, **(add)** **(subtract)** 180° if the azimuth is 180° or more.

(true north) (62)

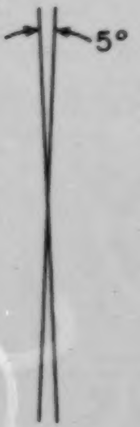
FRAME 63

Once you establish the direction of true north on the ground, you can orient your map because the ____________ of a standard military map is its true north side.

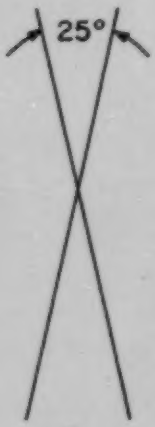
(Go on to the next frame) (92)

FRAME 93.

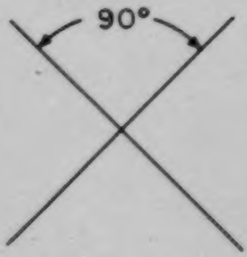
Which set of azimuth lines, plotted below, produce the sharpest point of intersection? ____________________



A



B



C

(west, south) (3)

FRAME 4.

In the lower (southwest) section of your LEAVENWORTH map is the City of Leavenworth. Look at the LEAVENWORTH map and find the City of Leavenworth. You located it by using the direction southwest. Locations can be partly determined by ____________________.

(subtract) (33)

FRAME 34.

If the azimuth is less than 180°, you ____________ 180° to obtain the back azimuth; if the azimuth is more than 180°, you ____________ 180° to obtain the back azimuth.

(top) (63)

FRAME 64.

Complete the following general rules that apply to map orientation by visual inspection.

a. Orient a map by visual inspection only when a ______________ is not available.

b. When orienting a map by visual inspection, select at least ______________ ______________ prominent terrain features.

c. You must know the direction of a linear feature to avoid ______________ ______________ the orientation.

d. Single features can be used to orient a map by visual inspection only if the observer knows his ______________ on the map.

(C) (93)

FRAME 94.

Refer again to the figure in frame 93. As a general rule, the sharpest intersection is obtained when azimuth sightings are approximately ______________ degrees apart.

(direction) (4)

FRAME 5.

Your unit is located in the City of Leavenworth. It is ordered to proceed south from the city by the 2-lane highway for about 2 miles and rendezvous with another unit at __________________ Cemetery.

(add, subtract) (34)

FRAME 35.

Determine the back azimuths for the directions listed below and write them in the spaces provided.

a. Grid azimuth = 95°; grid back azimuth = __________°

b. Magnetic azimuth = 210°; magnetic back azimuth = __________°

c. Grid azimuth = 359°; grid back azimuth = __________°

Set 4-8. USE OF PROTRACTOR TO PLOT AZIMUTHS

(compass, two, reversing, location) (64)

FRAME 65. INFORMATION FRAME.

A protractor is an aid to assist you in laying out and measuring azimuths on the map. Panel 4-8 illustrates four types of protractors. Notice that on the circular and square types, all 360 of the degrees of a circle are shown around the center. On the rectangular type, half the degrees, or 180°, are plotted, but values for the full 360° are shown. Some types show both mils and degrees; others are graduated in degrees only. Be sure you understand the protractor you are using, and use the correct values.

(90 degrees (See figure C, frame 93)) (94)

FRAME 95.

Panel 4-13 indicates how intersection is accomplished. To perform intersection, you must take sightings on the unmapped object from at least ____________ known locations. ✓

(Mt Calvary) (5)

FRAME 6.

You have located Mt. Calvary Cemetery as about 2 miles south of the City of Leavenworth. Now both units are ordered to proceed to the town of Richardson which is about 1 mile to the ____________________ of Mt. Calvary Cemetery.

a. north b. south c. east d. west

(A. 275°, B. 30°, C. 179°) (35)

FRAME 36. INFORMATION FRAME.

A mil is also used by the map reader to express direction. For military purposes a circle is divided into **6,400 mils.** Mils are of particular interest to gunners because a change of 1 mil in the angle of a weapon will change the impact of a shell or bullet a distance of 1 unit for every 1,000 units of range.

(Go on to the next frame) (65)

FRAME 66.

Your protractor has an index point from which the degrees are scaled. If a full 360° are shown, the index point is in the center. It is usually indicated by crossed lines. If your protractor is semicircular or rectangular, only half the degrees are plotted along the semicircle or on three sides of the rectangle. The index point from which the degrees are scaled is in the center of the diameter side of the protractor. It is usually indicated by an arrow. On your protractor, all the degrees are scaled from the ____________________.

(two) (95)

FRAME 96.

If you sight an enemy field fortification which is not shown on your map, you would locate it on the map as follows (pick one response):

a. First take an azimuth from your known position, then move to a new location which can be located on the map and take a second azimuth.

b. First take an azimuth from your known position, then move to another location and take a second azimuth.

(C. east) (6)

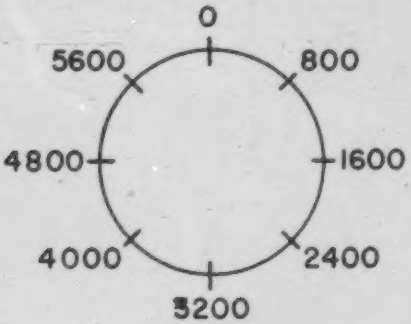
FRAME 7. SUMMARY FRAME.

You have seen that locations can be given by simply stating, for example, that a place is 1 mile along a road to the east or that you should take the 2-lane road south of the city for 2 miles to rendezvous at a cemetery. In the following frames, you will learn how to plot directions on a map and locate a point (for example, an enemy gun position) which may not be on a road or other readily identifiable feature.

(Go on to the next frame) (36)

FRAME 37.

The figure below shows a circle divided into mils. Note that, like an azimuth angle and degrees, mils are also numbered in a **(clockwise) (counterclockwise)** direction.



(index point) (66)

FRAME 67. INFORMATION FRAME.

To plot an azimuth from a known point, study the steps outlined in Panel 4-9.

(a.) (96)

FRAME 97.

To locate on your map the unmapped object at A in Panel 4-13, you would first orient the map, and then determine ________________ ________________ on the map.

Set 4-2. NORTH LINES

FRAME 8.

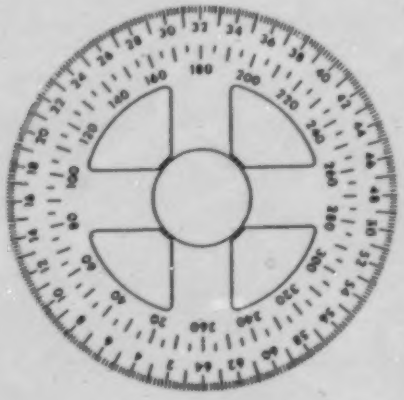
Directions may also be expressed in everyday life as: "on the right side of the road", "on the left bank of the river", etc. In these examples, the ______________ and the ______________ have been used as references from which to express direction.

(clockwise) (37)

FRAME 38.

Compare the mil circle to the degree circle and complete the following table:

Mils		Degrees
1600	=	____
____	=	270°
____	=	225°
5600	=	____


20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
120
140
160
180
200
220
240
260
280
300
320
340
360
20
40
60
80
100

(Go on the next frame) (67)

FRAME 68.

It is seen that the protractor index must be over the ________________ and that the protractor index line (0° to 180°) must be over the ________ ________ line drawn through the point.

(your location) (97)

FRAME 98.

Once your location has been determined, you would take a compass sighting on the unmapped object, convert to a grid azimuth, and then ________________ the ________________ on your map.

(road, river) (8)

FRAME 9.

In military map reading, directions are referenced to a **north** line instead of to roads, rivers, etc. The ______________________ line serves as a reference line from which directions are expressed.

Set 4-5. DECLINATION DIAGRAM AND G-M ANGLE

(1600 mils = 90°, 4800 mils = 270°, 4000 mils = 225°, 5600 mils = 315°) (38)

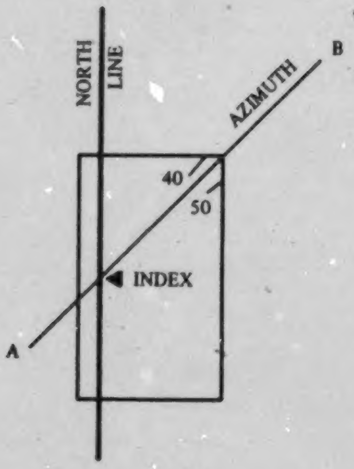
FRAME 39. INFORMATION FRAME.

Azimuths and back azimuths can be plotted accurately on a map by referring to the declination diagram in the lower map margin (see LEAVENWORTH map and Panel 4-4). Magnetic declination is the angular difference between true north and magnetic north. However, since the military user is primarily interested in the difference between grid north (on his map) and magnetic north (on his compass), the diagram shows the value of this angle, called the grid-magnetic (G-M) angle, and the relative directions of the different norths. Notes printed next to the diagram tell you how to convert from one type of azimuth to another on that particular map. The angle of grid convergence, which is the difference between true north and grid north, is also shown.

(point, north) (68)

FRAME 69.

In the figure below, the protractor has been oriented correctly to measure the azimuth of line A-B, with respect to a grid north line. What is the azimuth of line from point A to point B?



Azimuth of Line A-B = ________°

(plot, azimuth) (98)

FRAME 99.

You then move to a second known point, take another ____________ on the unmapped object, convert to a grid azimuth, then ____________ the second ____________ on your map.

(north) (9)

FRAME 10.

Three north lines, from which directions are measured in map reading, are shown in Panel 4-1. Study this panel. Complete the chart below.

SYMBOL	NORTH LINE
↿	a. ________ ________
★	b. ________ ________
"GN" or "Y"	c. ________ ________

(Go on to the next frame) (39)

FRAME 40.

A dashed-line arc is drawn on the declination diagram to connect the ____________ north and magnetic north lines.

(45° NOTE: The degrees printed on the edge of the protractor increase in a clockwise direction) (69)

FRAME 70.

To obtain the grid azimuth of a line on a map, you can use as a base line either the grid north line or a line drawn ____________________ to it. You would then use your protractor to measure the angle formed between the base line and the line on the map (Panel 4-9).

(sighting, plot (draw), azimuth) (99)

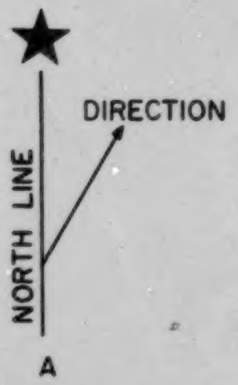
FRAME 100.

The grid coordinates of the unmapped object can be determined from the point at which the two grid azimuths plotted on the map ____________________.

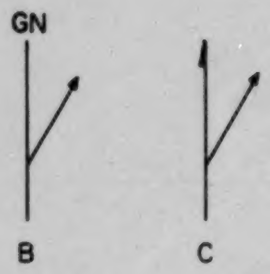
(a. Magnetic north, b. True north, c. Grid north) (10)

FRAME 11.

A direction measured from a true north line may be illustrated as shown in A below. Under the diagrams in B and C below, write the name of the north line from which the indicated direction is measured.



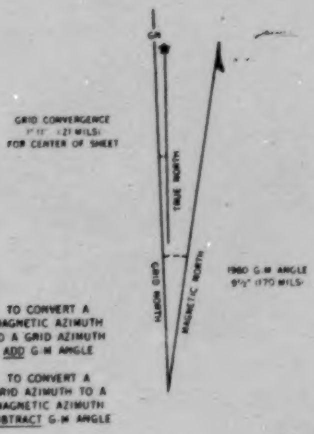
NORTH LINE
DIRECTION
A



(grid) (40)

FRAME 41.

The arc connecting the grid north and magnetic north lines is called a grid-magnetic (G-M) angle. The grid-magnetic angle shown is __________________ degrees or __________________ mils.



GN
GRID CONVERGENCE
1° 11' (21 MILS)
FOR CENTER OF SHEET
TRUE NORTH
GRID NORTH
MAGNETIC NORTH
1960 G-M ANGLE
9½° (170 MILS)
TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH ADD G-M ANGLE
TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH SUBTRACT G-M ANGLE

(parallel) (70)

FRAME 71.

Refer again to the figure below frame 69. What is the back azimuth of line from point A to point B? (Frame 27 explains how to compute back azimuths)

Back azimuth of line A-B = __________°.

(intersect) (100)

FRAME 101.

Do the following exercise in intersection on your LEAVENWORTH map. Your first known location is at 443662. These coordinates identify your location as being at ________________ ________________. Mark this position A

(B. grid north, C. magnetic north) (11)

FRAME 12.

Refer again to Panel 4-1 and draw the appropriate symbols of the north lines which are described below.

LINE DERIVED FROM	SYMBOL
a. Compass direction of magnetic north.	a. ________
b. Easting grid lines on a map.	b. ________
c. Earth's north pole.	c. ________

(9½ degrees, 170 mils) (41)

FRAME 42. INFORMATION FRAME.

The date of the G-M angle information is also noted on the diagram. Because the angle may change slightly as the magnetic pole changes its position, this information is usually updated every five years.

(225°) (71)

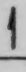
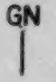
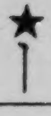
FRAME 72.

Since the azimuth is less than 180°, the back azimuth is computed by adding 180°. Thus, the back azimuth is 45° + 180° = 225°. If the azimuth is between 180° and 360°, you ______________________ 180° to obtain the back azimuth.

(Flintlock Church) (101)

FRAME 102.

From your position at the church you take a compass sighting of 54°30′ to an enemy gun emplacement. Using the declination diagram on your map, you convert this magnetic azimuth to a grid azimuth of __________°.

(a.  ________, b.  ________, c.  ________) (12)

FRAME 13.

In the space provided below, draw the symbols of the three north lines, write the names of the lines, and state how the lines are derived. What determines the direction of each?

	SYMBOL	NAME	HOW DERIVED
a.	________	________ ________	________
b.	________	________ ________	________
c.	________	________ ________	________

(1965) (42)

FRAME 43.

The arc connecting the **grid north** and **magnetic north** lines is called a ________ ________ angle.

(subtract) NOTE: Back azimuths may also be read directly on your protractor, as explained in Panel 4-9, Note No. 2. (72)

FRAME 73.

For measuring azimuths from 0° to 180°, the protractor is read to the (right) (left) of the north line. For measuring azimuths from 180° to 360°, the protractor is read to the (right) (left) of the north line.

(64°) (102)

FRAME 103.

Use your protractor and a straightedge and plot the grid azimuth of 64° through position A.

a.	★	True north	Earth's north pole
b.	↗	Magnetic north	Compass direction of magnetic north
c.	GN	Grid north	Easting grid lines on map (13)

FRAME 14.

Any line you draw on the map parallel to the grid north lines shown on your map is a grid north line. Similarly, any lines ________________ to the magnetic north and true north lines shown on your map are magnetic north or true north ________________. Grid north lines and magnetic north lines are most commonly used in determining direction on military maps.

(grid-magnetic (G-M) angle) (43)

FRAME 44.

Refer to the LEAVENWORTH map provided with this text. Locate the declination diagram in the bottom margin. The G-M angle on the LEAVENWORTH map is __________ degrees or __________ mils and was prepared in

____________.

(right, left) (73)

FRAME 74.

Turn to Panel 4-10. Draw a line connecting points A and B, points A and C, and points A and D. Use your protractor to find the azimuths of these lines and enter your answers in the spaces provided below.

Line	Azimuth
Point A to Point B	________°
Point A to Point C	________°
Point A to Point D	________°

(Go on to the next frame) (103)

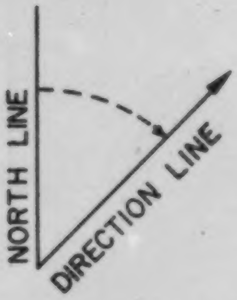
FRAME 104.

You would now move to a second known position, for example, to the road junction at 450695. Label this position B.

(parallel, lines) (14)

FRAME 15.

The most common military method of expressing a direction is by using an azimuth. The figure below shows a north line and a direction. The angle between the north line and the direction line, shown by a dashed line, is an __________.



(9½ degrees, 170 mils, 1960) (44)

FRAME 45.

The angle at which a magnetic north line plotted on a map intersects an easting grid line is known as the ________ ________.

Line	Azimuth
Point A to Point B	45°
Point A to Point C	92°
Point A to Point D	226° (74)

FRAME 75.

Turn to Panel 4-11. Using easting grid line 41 as a base line, measure the azimuth of the line drawn from Point A to Point B. The azimuth is ___________ degrees.

(Go on to the next frame) (104)

FRAME 105.

From your new location at the road junction (position B), you take a compass sighting of 119° to the gun emplacement. You convert this to a grid azimuth of _________° _________′.

(azimuth) (15)

FRAME 16.

The arrow on the dashed line in frame 15 shows that the azimuth angle is measured in a (clockwise) (counterclockwise) direction from the north line.

(G-M angle) (45)

FRAME 46.

Study the declination diagram on the map. The GRID NORTH line is parallel to the ____________________ grid lines on the map.

(63 degrees) (75)

FRAME 76.

Refer to Panel 4-11. The line from Point A to Point B has a ____________ azimuth of 63 degrees.

(128° 30′) (105)

FRAME 106.

Plot the grid azimuth of 128° 30′ through position B.

(clockwise) (16)

FRAME 17.

All azimuths are measured in the same manner—they are measured in a ____________________ direction from the north line.

(easting) (46)

FRAME 47.

If a magnetic north line were plotted on the LEAVENWORTH map, it would intersect an easting grid line at an angle of ____________ degrees ____________ minutes.

(grid) (76)

FRAME 77.

Again turn to Panel 4-11. Using easting grid line 42 as a north line, measure the azimuth of the line drawn from Point X to Point B. The azimuth is __________ degrees.

(Go on to the next frame) (106)

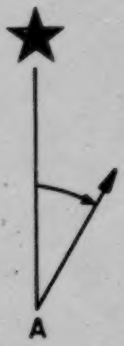
FRAME 107.

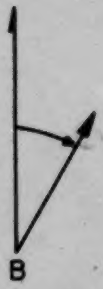
Extend the two azimuths until the lines intersect. The grid coordinates of the enemy gun emplacement are ____________________.

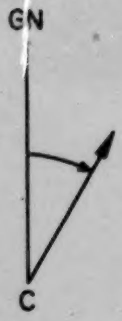
(clockwise) (17)

FRAME 18.

Figure A shows a "true azimuth angle", so named because the azimuth angle shows a direction as related to a true north line. B shows a __________ __________ __________ and C shows a __________ __________ __________.







Set 4-6. USE OF COMPASS TO ORIENT MAP

(9°, 30′) (47)

FRAME 48. INFORMATION FRAME.

The magnetic compass is the most commonly used and simplest instrument for measuring directions and angles in the field. A lensatic compass is shown in Panel 4-2.

(63 degrees) (77)

FRAME 78.

Refer to Panel 4-11. The line from Point X to Point B has a ______________ azimuth of 63 degrees.

(473676) (107)

Set 4-11. RESECTION

FRAME 108. INFORMATION FRAME.

Panel 4-14 indicates how resection is accomplished. To perform resection you must take sights on ____________________ or more objects of known location from your unknown location.

(B. magnetic azimuth angle; C. grid azimuth angle) (18)

FRAME 19.

Azimuth angles are commonly expressed in degree units of angular measure. A true azimuth of 45 degrees (written as 45°) is, therefore, a direction. It tells us that—

a. The north line used as a reference for measuring was a ____________ ________________ line.

b. The azimuth of 45° was measured in a ________________ direction.

(Go on to the next frame) (48)

FRAME 49.

Look at the compass dial in Panel 4-3. You see that it is graduated (has measurement ticks) in _________ and _________. The outer ring of numbers contains the _________ graduations and the inner ring, the _________ graduations.

(grid) (78)

FRAME 79.

All lines drawn through a point and parallel to easting grid lines can be used to measure ____________ ____________.

(two) (108)

FRAME 109.

Study Panel 4-14. The first thing you should do when performing resection is to ____________ the ____________.

(a. true north, b. clockwise) (19)

FRAME 20.

A degree is $\frac{1}{360}$ part of a circle. Therefore, a circle contains _______ degrees.

(mils, degrees, mil, degree) (49)

FRAME 50.

A closer look at a portion of the dial (Panel 4-3) indicates that the measurement marks on the mil scale are separated by ___________________ mils, and those on the degree scale are separated by _________________ degrees.

(grid azimuth) (79)

FRAME 80.

Also, because a straight line crosses all grid norths at the same angle, the straight line can be extended in either direction and a grid azimuth taken at the new points it crosses the ______________ ______________ ______________.

(orient, map) (109)

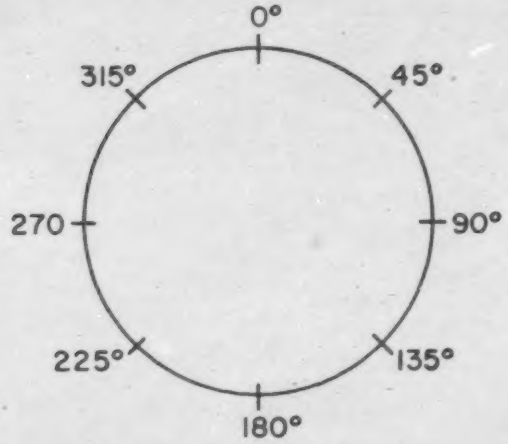
FRAME 110.

Do the following exercises in resection on your LEAVENWORTH map. From your present **unknown** location, you take a compass sighting on the road junction at 393518. Mark the road junction on the map, point A. The magnetic azimuth to point A is 281° 30′. This means the grid azimuth will be __________°.

(360) (20)

FRAME 21.

The figure below shows a circle divided into degrees. Note that like an azimuth, degrees are numbered in a **(clockwise) (counterclockwise)** direction.



(20 mils, 5 degrees) (50)

FRAME 51. INFORMATION FRAME.

To use the compass, the sighting slot in the eyepiece, the sighting wire in the front cover, and the target are alined. The magnetic azimuth can be read by glancing down at the dial through the lens, and reading the value under the index line on the face of the compass.

(grid north lines) (80)

FRAME 81.

Line A-B in Panel 4-11 crosses each easting grid line at the same ________. Therefore, the grid azimuth is the same when measured at ________________ easting grid line.

(291°) (110)

FRAME 111.

What is the back grid azimuth of 291°? ________________

(clockwise) (21)

FRAME 22.

Each degree is further divided into 60 minutes (written as 60′). Therefore, 9½ degrees can be written ________° ________′.

(Go on to the next frame) (51)

FRAME 52.

Azimuths are read by observing the mil or degree graduation appearing under the index line. Indicate in the spaces provided below the magnetic azimuths which are shown on the compass dials pictured in Panel 4-5.

a. ________ degrees, ________ mils

b. ________ degrees, ________ mils

(angle, any) (81)

FRAME 82.

Determine the grid azimuth of the line in Panel 4-11 which is drawn from Point Y to Point B. The grid azimuth is ____________________.

(111°) (111)

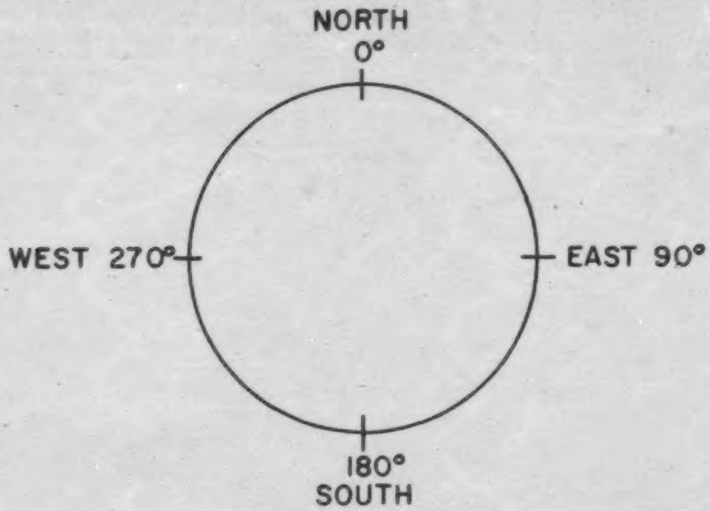
FRAME 112.

Plot the back grid azimuth of 111° from point A and extend the line toward the general direction of your location. The next step in resection is to take a ____________________ ____________________ on a second identified terrain feature.

(9° 30′) (22)

FRAME 23.

Consider that you are standing in the center of the circle shown below. When you face towards any north (true, grid or magnetic) you are facing 0° (or 360°). When facing to the west, you are facing __________ degrees.



(a. 52 degrees or 940 mils, b. 266 degrees or 4740 mils) (52)

FRAME 53. INFORMATION FRAME.

When you place a map so that all its directions are alined with corresponding directions on the ground, the map is said to be oriented.

(80°) (82)

FRAME 83.

Turn to Panel 4-12. Determine the grid azimuths of the lines indicated below, and complete the chart. (Hint: Extend lines A-X, etc. in order to read on protractor.)

Line	Grid Azimuth
From Point A to Point X	________°
From Point B to Point X	________°
From Point C to Point X	________°

(compass sighting) (112)

FRAME 113.

You now sight on the second identified terrain feature, a road junction at 426522. Mark this road junction as point B. You then determine the magnetic azimuth to point B to be 33°. What is the grid azimuth? ________________

(270 degrees) (23)

FRAME 24.

When standing at the center of the circle facing towards the north, and desiring to face towards the east, you must turn _________ degrees in a clockwise direction.

(Go on to next frame) (53)

FRAME 54.

To orient a map, you position the map so that map directions are alined with corresponding __________________ directions.

Set 4-9. CONVERSION OF AZIMUTHS

(45°, 90°, 329°) (83)

FRAME 84.

Refer to your LEAVENWORTH *map. Use your protractor to measure the* grid azimuth from BM 761 at coordinates 419491, to BM 972 at coordinates 489516. The grid azimuth is ________° ________′.

(42° 30′) (113)

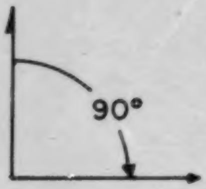
FRAME 114.

What is the back grid azimuth of 42° 30′? ________________

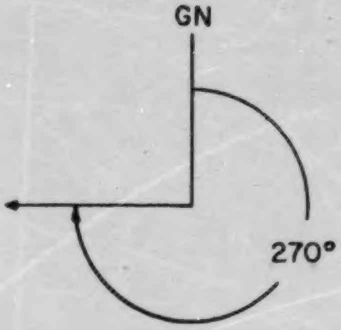
(90 degrees (90°)) (24)

FRAME 25.

In the spaces below, write the azimuths indicated in sketches A and B.



A



B

A. __________ azimuth of __________° B. __________ azimuth of __________°

(ground) (54)

FRAME 55.

A map can be oriented with a compass. Panel 4-6 shows how this orientation is accomplished. Study this panel. The compass sighting wire is placed over an ____ line.

(70° 45′ (45′ is estimated, as angle is greater than 70° 30′ and less than 71°)) (84)

FRAME 85.

After determining the grid azimuth from BM 761 to BM 792 to be 70° 45′, you can determine the magnetic (compass) azimuth by **(adding) (subtracting)** 9° 30′.

(222° 30′) (114)

FRAME 115.

Plot the back grid azimuth of 222° 30′. Extend the plotted line to intersect with the back azimuth line you have drawn from point A. You are located at the intersection of these two lines which is at (coordinates) ____________________.

(A. Magnetic azimuth of 90°, B. Grid azimuth of 270°) (25)

FRAME 26.

Above the captions below, sketch in the azimuths called for. Show the angle size and direction of measurement.

A. Grid azimuth of 210°.   B. Magnetic azimuth of 90°.

(easting grid) (55)

FRAME 56.

Following orientation, all map lines are ________________ to their corresponding lines on the ground.

(subtracting. (Note: The conversion rules for converting grid and magnetic azimuths are printed adjacent to the declination diagram in the bottom margin of each map. See your LEAVENWORTH map.)) (85)

FRAME 86.

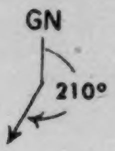
The magnetic azimuth from BM 761 to BM 792 is ________° ________′.

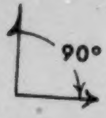
(415510) (115)

FRAME 116. INFORMATION FRAME.

In rare instances, where you are standing on a linear terrain feature, which can be identified on your map (e.g., a railroad, road, river bank, etc.) it may be necessary to sight on only one identified terrain feature to perform resection. Use your LEAVENWORTH map to perform the following resection problem to illustrate how only one azimuth need be drawn to locate your position when you are standing on an identified linear terrain feature.

Set 4-4. BACK AZIMUTH MEASUREMENT





(A. Grid azimuth of 210°, B. Magnetic azimuth of 90°) (26)

FRAME 27. INFORMATION FRAME.

In map reading, it is often required that a **back azimuth** be determined. A back azimuth is the **reverse** direction of an azimuth. It is comparable to doing an "about-face". It is the **opposite** direction of the azimuth. Back azimuths are used to determine the position of the observer or unit when the location is not known. This will be discussed in later frames.

Set 4-7. ORIENTATION OF MAP BY VISUAL INSPECTION

(parallel) (56)

FRAME 57.

When a compass is not available, a map can be oriented as shown in Panel 4-7 by ____________________ inspection. Orientation of a map by visual inspection is recommended only when a ____________________ is not available.

(61° 15′) (86)

FRAME 87.

Refer to your LEAVENWORTH map. You are located at Fancy Bottom School, at coordinates 339647. The grid azimuth from your position to Coffin School, at coordinates 306600, is ________°.

(Go on to the next frame) (116)

FRAME 117.

You are standing on the Burlington and Quincy railroad, somewhere between IATAN in grid square 2971 and WESTON in grid square 3664. You make a compass sighting on the church steeple in the town of KICKAPOO, at 30306295, and read a magnetic azimuth of 215° 30′, which is a grid azimuth of ___________.

(Go on to the next frame) (27)

FRAME 28.

If you desired to turn from facing north (0°) to facing south, you would turn ________ degrees.

(visual, compass) (57)

FRAME 58.

Orientation of a map by visual inspection consists of adjusting the position of the map until distinctive features identified on the ground are in the same relative positions on the map. At least ________________ prominent features are usually needed.

(215°) (87)

FRAME 88.

The magnetic (compass) azimuth of the line from Fancy Bottom School to Coffin School is __________° __________.

(225°) (117)

FRAME 118.

Plot the back azimuth of 225°, which is __________°, from the church to the railroad.

(180°) (28)

FRAME 29.

If you are facing east (90°) and do an about-face, you will be facing ______ which is ______ degrees.

(two) (58)

FRAME 59.

If you know your ground position and can identify it on the map, you can orient the map by alining your plotted position with at least one other feature identified on the map and visible on the ground. To use this method, you must be able to locate your position and another feature both on the ______ and on the ______.

(205° 30′. (See conversion rule adjacent to declination diagram on LEAVENWORTH map.)) (88)

FRAME 89.

The magnetic azimuth of a line from Coffin School to Fancy Bottom School is ________°

(45°) (118)

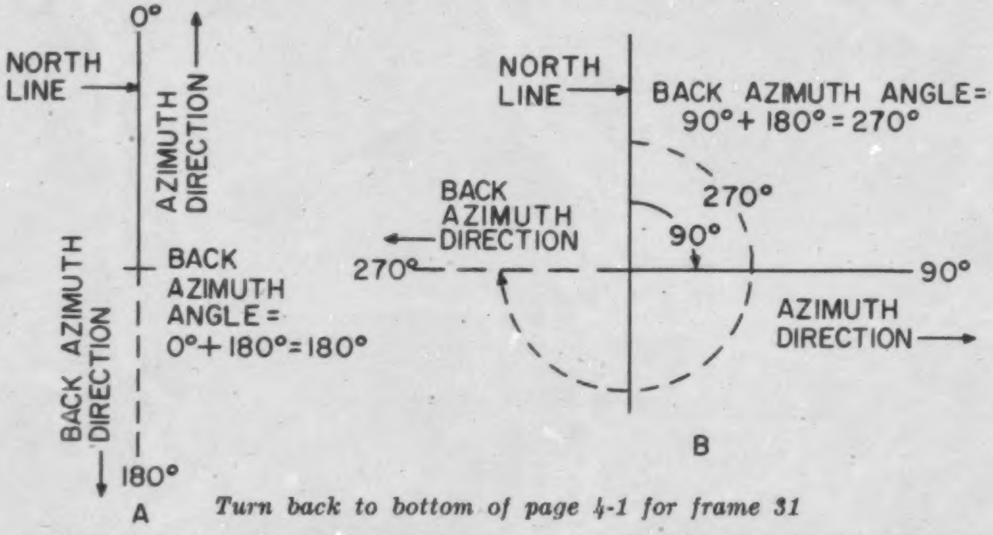
FRAME 119.

Your location on the railroad is determined by the intersection of the back grid azimuth line of 45° with the railroad. You are located on the railroad at coordinates ____________________.

(West, 270°) (29)

FRAME 30.

The facing movements, just discussed, are shown as azimuths and back azimuths below. Both back azimuths were obtained by adding ______________° to the original direction (azimuth) in which you were facing.


0°
NORTH LINE
AZIMUTH DIRECTION
BACK AZIMUTH ANGLE = 0°+180°=180°
BACK AZIMUTH DIRECTION
180°
A
NORTH LINE
BACK AZIMUTH ANGLE = 90°+180°=270°
270°
90°
BACK AZIMUTH DIRECTION
270°
90°
AZIMUTH DIRECTION
B

Turn back to bottom of page 4-1 for frame 31

(ground, map) (59)

FRAME 60.

A linear feature, such as a road, railroad, or stream bed, is useful for orientation if you can determine its ________________.

Turn back to top of page 4-2 for frame 61

(25° 30′. (This is a back magnetic azimuth of the magnetic azimuth you calculated in the previous frame; therefore it may be obtained as 205° 30′ − 180° = 25° 30′.)) (89)

FRAME 90.

Refer to your LEAVENWORTH MAP. You are located at COFFIN SCHOOL at coordinates 306600, and take a compass sighting to the water tower located at coordinates 333589. If your compass reading is 103°, the grid azimuth to the water tower is ________° ________′.

Turn back to bottom of page 4-2 for frame 91

(336663) (119)

FRAME 120.

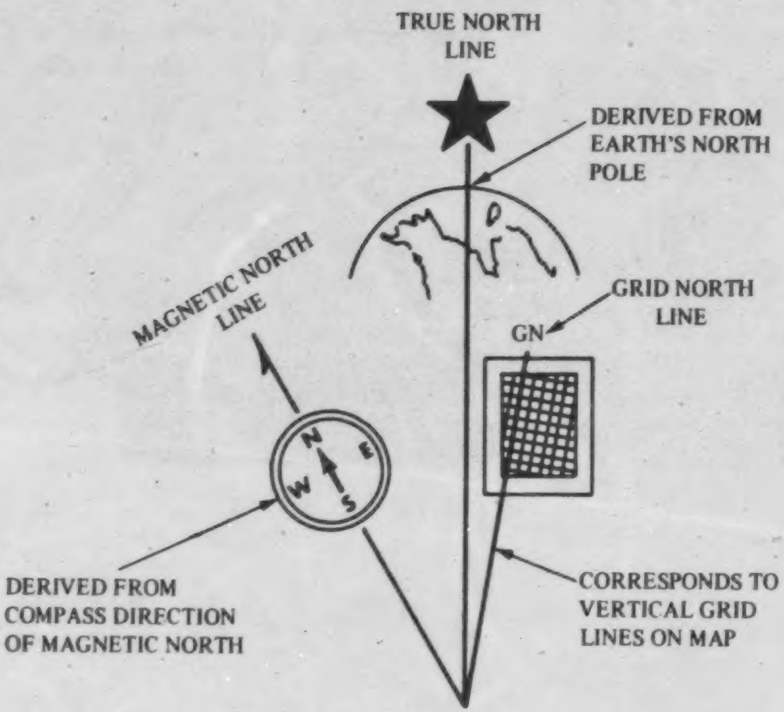
Unless you are standing on a ________________ terrain feature which you can identify on the map, at least ________________ features appearing on the map must be sighted from your unknown location in order to accurately accomplish resection.

(linear, two) **(120)**

END OF FRAMES FOR PART IV

PANEL 4-1

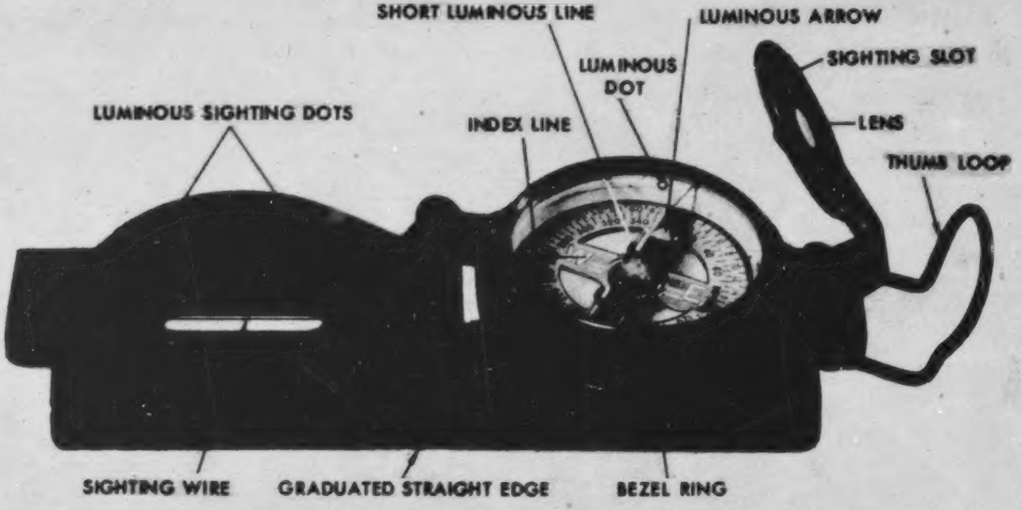
MAGNETIC NORTH, TRUE NORTH, AND GRID NORTH


TRUE NORTH LINE
DERIVED FROM EARTH'S NORTH POLE
MAGNETIC NORTH LINE
GRID NORTH LINE
GN
N
E
W
S
DERIVED FROM COMPASS DIRECTION OF MAGNETIC NORTH
CORRESPONDS TO VERTICAL GRID LINES ON MAP

NOTE: THE LETTER "Y" CAN BE USED INSTEAD OF "GN"

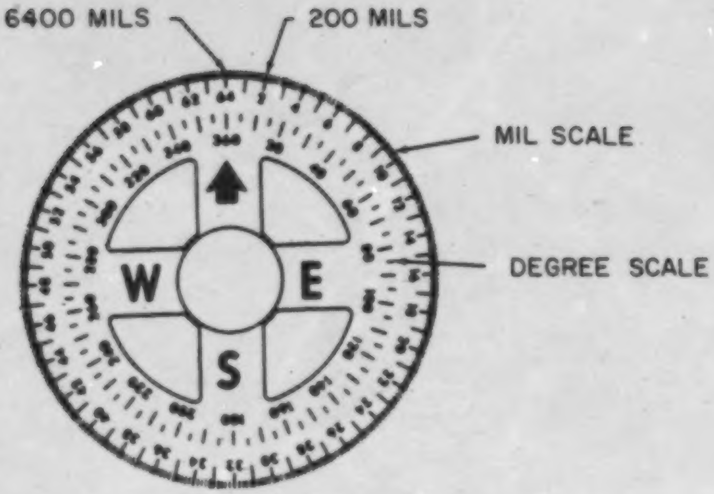
PANEL 4-2

LENSATIC COMPASS


SHORT LUMINOUS LINE
LUMINOUS ARROW
SIGHTING SLOT
LUMINOUS DOT
LUMINOUS SIGHTING DOTS
INDEX LINE
LENS
THUMB LOOP
SIGHTING WIRE
GRADUATED STRAIGHT EDGE
BEZEL RING

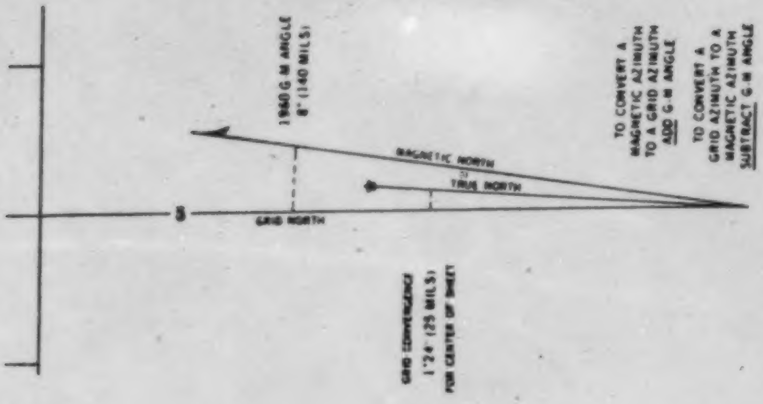
PANEL 4-3

COMPASS DIAL


6400 MILS
200 MILS
MIL SCALE
DEGREE SCALE
W
E
S

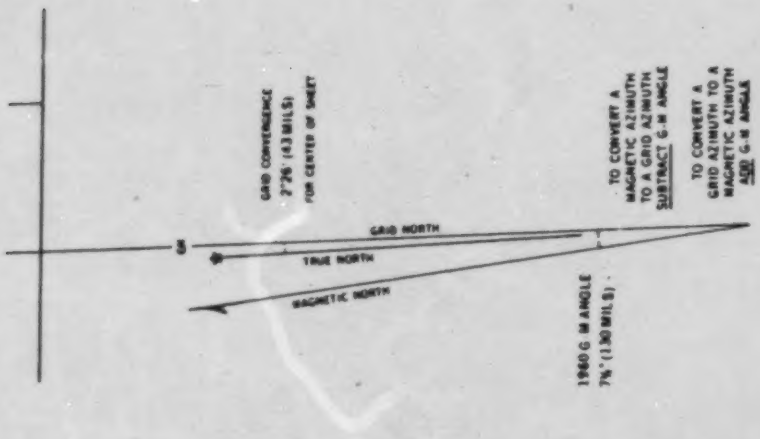
PANEL 4-4

DECLINATION DIAGRAMS


1960 G-M ANGLE
8° (140 MILS)
MAGNETIC NORTH
TRUE NORTH
GRID NORTH
S
GRID CONVERGENCE
1°24' (25 MILS)
FOR CENTER OF SHEET

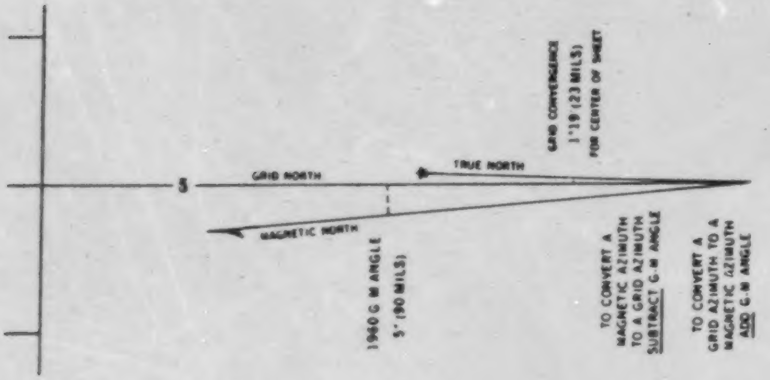
TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH ADD G-M ANGLE

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH SUBTRACT G-M ANGLE


GRID CONVERGENCE
2°26' (43 MILS)
FOR CENTER OF SHEET
GRID NORTH
S
TRUE NORTH
MAGNETIC NORTH
1960 G-M ANGLE
7½° (130 MILS)

TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH SUBTRACT G-M ANGLE

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH ADD G-M ANGLE

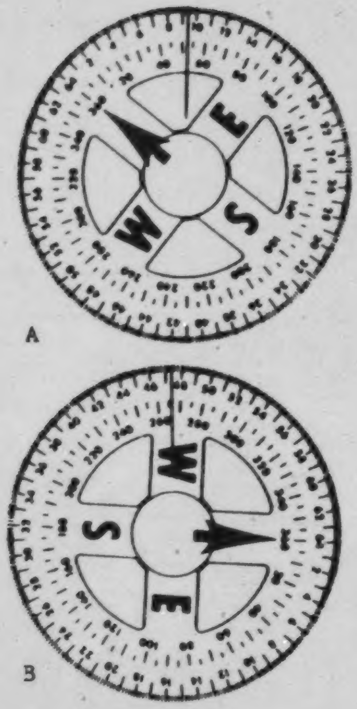

GRID CONVERGENCE
1°19' (23 MILS)
FOR CENTER OF SHEET
TRUE NORTH
GRID NORTH
S
MAGNETIC NORTH
1960 G-M ANGLE
5° (90 MILS)

TO CONVERT A MAGNETIC AZIMUTH TO A GRID AZIMUTH SUBTRACT G-M ANGLE

TO CONVERT A GRID AZIMUTH TO A MAGNETIC AZIMUTH ADD G-M ANGLE

PANEL 4-5

MAGNETIC AZIMUTHS READ FROM COMPASS

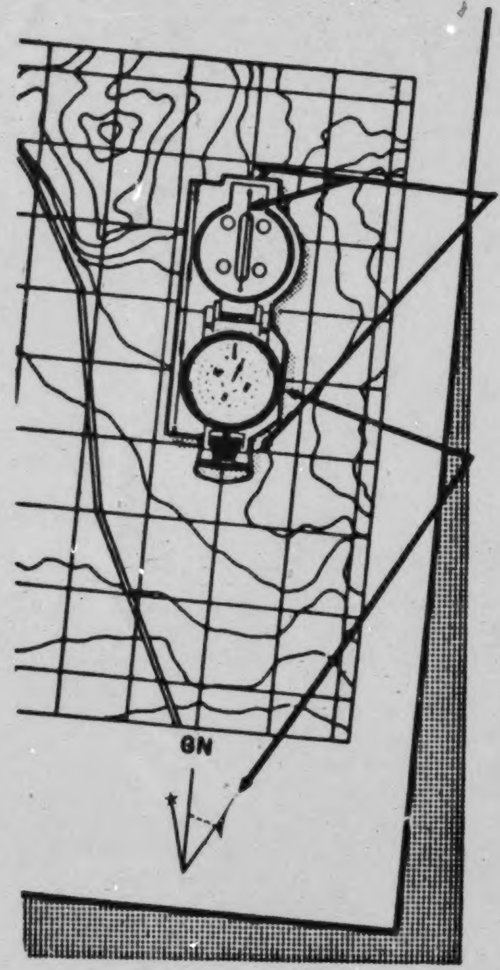


A

B

PANEL 4-6

TO ORIENT YOUR MAP BY COMPASS

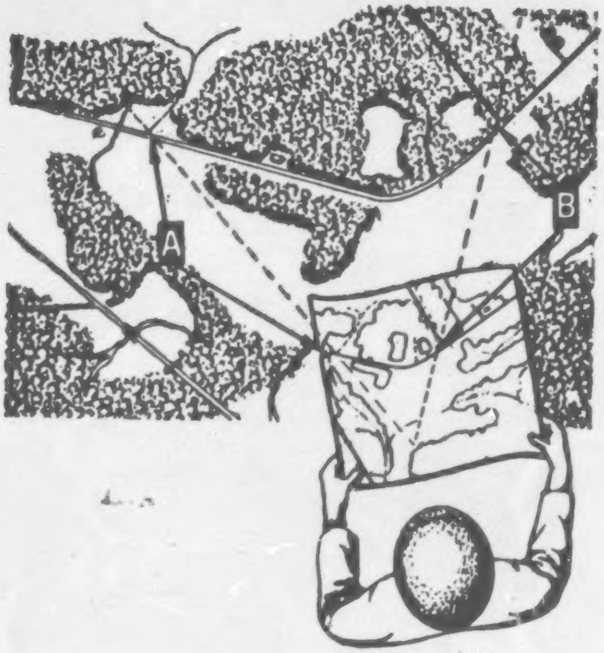


1 Aline sighting wire and notches at front and rear of compass over any north-south grid line. This places the index line on the face of the compass parallel to grid north.

2 Rotate map and compass together until the angle formed by the north needle and index line is the same value and relationship as shown for the G-M angle in the declination diagram in the map margin.

PANEL 4-7

ORIENTING A MAP BY VISUAL INSPECTION



1. At least two prominent features such as A and B are usually needed for orientation. You must locate them on the map as well as on the ground, and adjust the map until both ground features are alined with their map symbols.

2. If you can locate your position on the map, you can orient it by alining your plotted position with one additional prominent feature which is visible from your position and plotted on the map.

3. If the feature is linear, it is necessary to know its direction to avoid reversing the orientation. If you cannot determine the direction of the linear feature, at least one additional prominent feature is needed to orient the map.

4. A map may be roughly oriented by determining the direction of true north. The top of a standard military map represents true north. You can determine the approximate direction of true north on the ground by various expedient methods, such as the following:

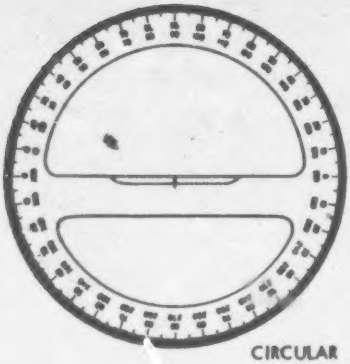
a. Observe the movement of the sun. In the northern hemisphere, it moves from east to south (at noon) to west.

b. Locate Polaris, the North Star.

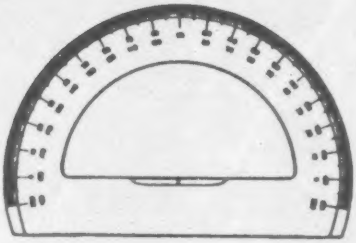
c. Observe the movement of shadows. They move from west to north (at noon) to east.

If you stand with east on your right, you will be facing north

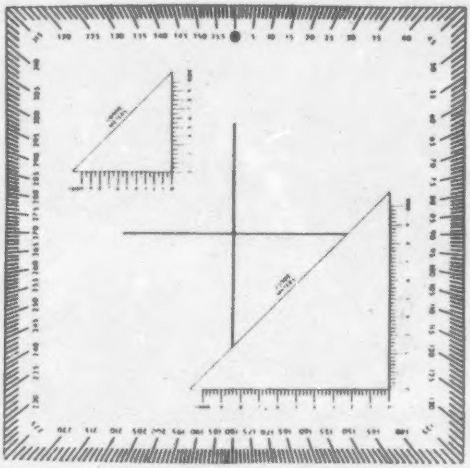
PANEL 4-8



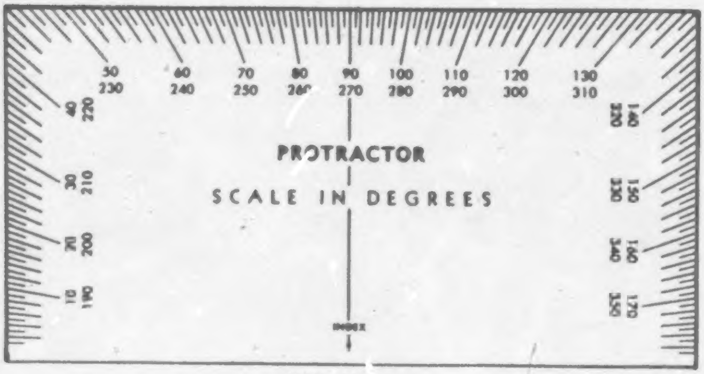
CIRCULAR



SEMICIRCULAR



SQUARE


50
230
60
240
70
250
80
260
90
270
100
280
110
290
120
300
130
310
40
220
30
210
20
200
10
190
140
320
150
330
160
340
170
350
PROTRACTOR
SCALE IN DEGREES
INDEX

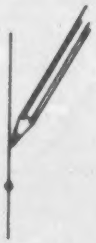
RECTANGULAR

Protractors

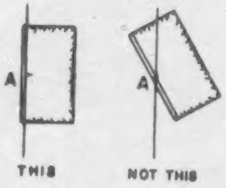
PANEL 4-9

USE OF PROTRACTOR IN PLOTTING AZIMUTHS

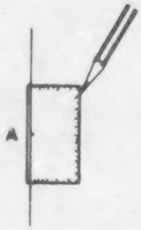
Step 1: Select a point from which the azimuth will be drawn, and construct a north line through the point parallel to an easting (north-south) grid line. There are several ways to construct the north line. One of the simplest is to use the map scale on your protractor as though reading the grid coordinates of the point (see Part II, frame 32). The leg of the map scale which runs through the point is parallel to the easting grid lines. Mark the place where this leg intersects the lower northing (east-west) grid line (the corner of the scale), and draw a line through both that point and the original point, extending it as necessary.



Step 2: Place the protractor index over the point, making certain the protractor index line (the 0° to 180° line) is over the north line which was drawn in step 1.

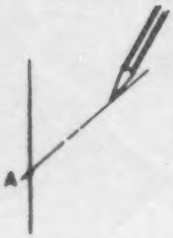


Step 3: Place a mark on the paper along the protractor edge at the desired azimuth. In the example, a 50° grid azimuth is given. Azimuths are normally plotted from grid lines on a map, and therefore must be grid azimuths. If you are given a magnetic (compass) azimuth you must consult the conversion rules in the bottom margin of your map. For the Leavenworth map, you see that you must add 9½° to convert from magnetic to grid azimuth. Hence, if a 50° magnetic azimuth were given, you would plot a 59½° grid azimuth on the map.

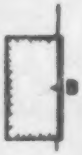


PANEL 4-9 (Continued)

Step 4: Remove the protractor and draw a line connecting point A with the mark drawn at 50°. The line is at a grid azimuth of 50° from the point on the north line which was drawn in Step 1.



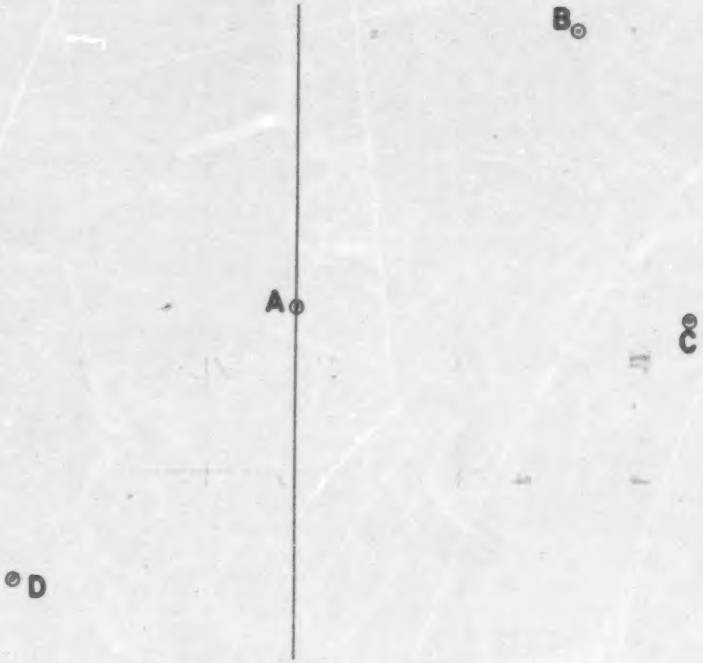
Note #1: If you are using a semicircular or rectangular protractor, the protractor is reversed, as shown at the right, for plotting azimuths greater than 180°. When you use the protractor in this position, you read the inner row of angle values (180° to 360°). The requirement to convert from magnetic azimuth to grid azimuth before plotting on the map applies regardless of the position of the protractor.



Note #2: Back azimuths may also be read directly from your protractor. If your protractor is circular or square, extend the azimuth line to intersect the opposite side of the protractor and read the back azimuth, making sure that the azimuth line passes through both the point and the protractor index point. If you have a rectangular protractor, with the double row of degree values, notice that the the inner row of values corresponds to the back azimuths for the outer row of values, and vice versa. For example, if you measure an azimuth of 40°, note that the corresponding back azimuth, 220°, is given on the inner scale for the same measurement.

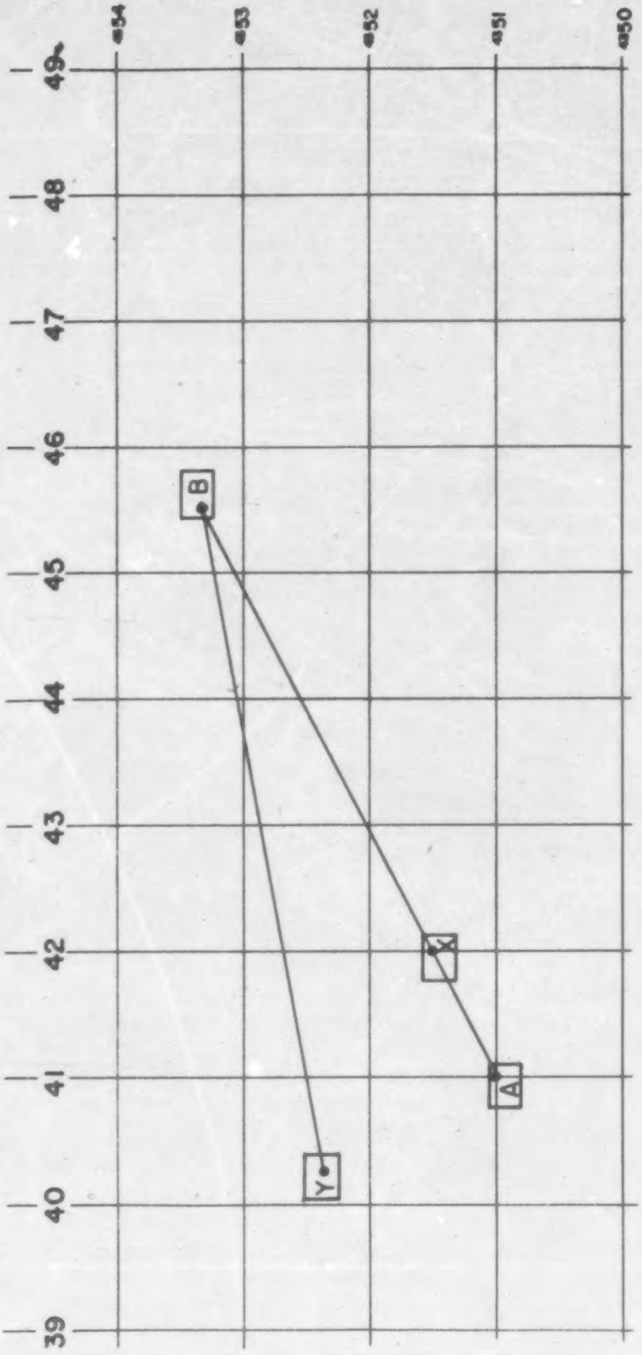
PANEL 4-10

MEASURING AZIMUTHS



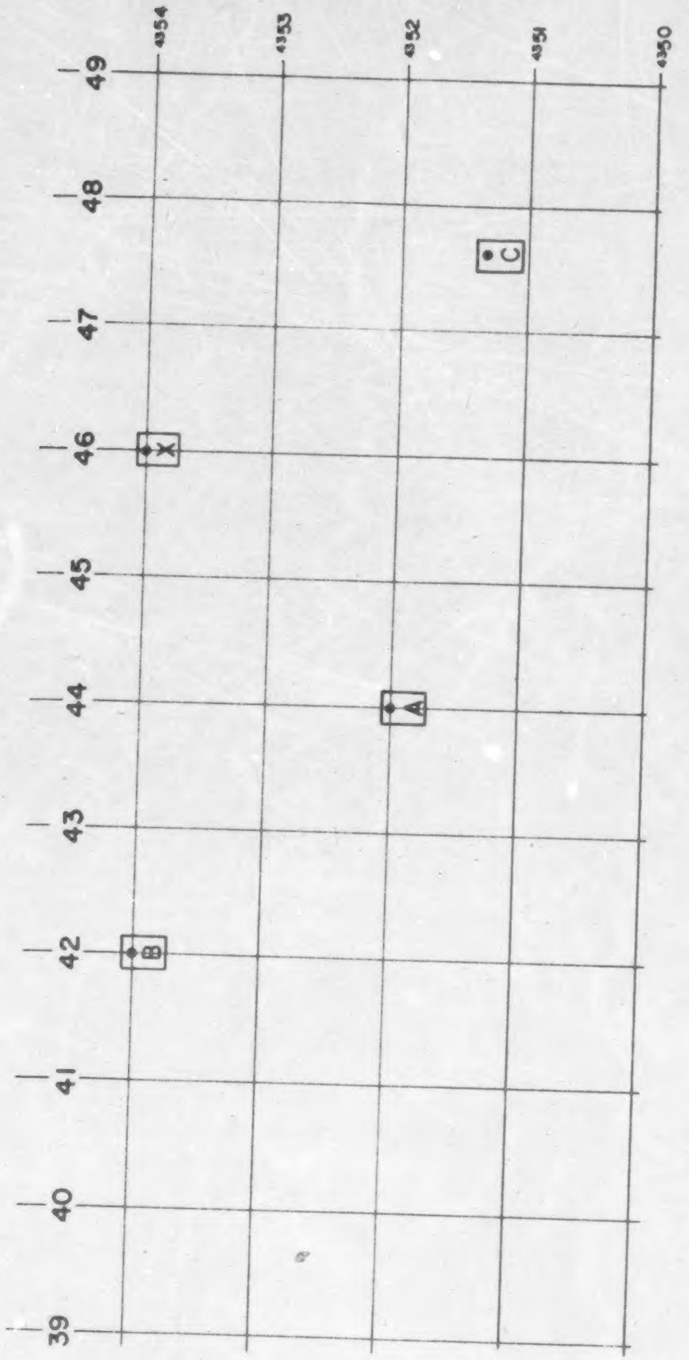
PANEL 4-11

GRID AZIMUTHS AND GRID LINES


454
453
452
451
450
49
48
47
46
45
44
43
42
41
40
39
B
X
A
Y

PANEL 4-12

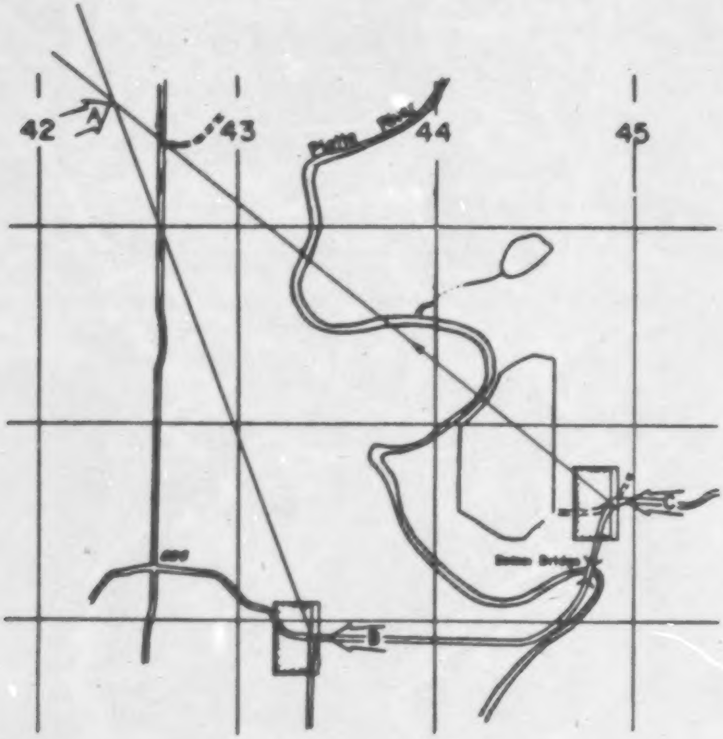
DETERMINING GRID AZIMUTHS


4354
4353
4352
4351
4350
49
48
47
46
45
44
43
42
41
40
39
X
A
B
C

PANEL 4-13

PERFORMING INTERSECTION

Locating an unknown point by successively occupying two (or more) known positions and sightings on the unknown point is called INTERSECTION.



Method:

A. Orient map.

B. Determine your location (at B), take sighting to unknown point (A), convert to grid azimuth, and plot azimuth (B-A) on your map.

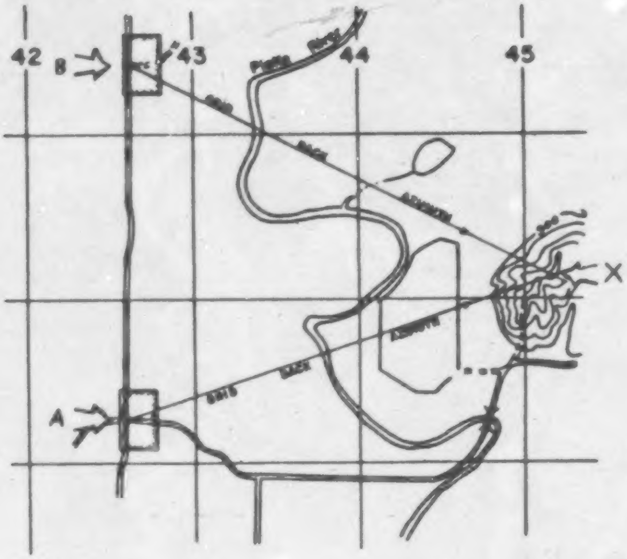
C. Move to new point (C), determine location, sight on A, convert to grid azimuth, plot azimuth (C-A) on your map.

D. Intersection of azimuths (B-A and C-A) on your map pinpoints map location of previously unknown point A.

PANEL 4-14

PERFORMING RESECTION

Locating your position by sighting on two known features is called RESECTION.



METHOD:

A. Orient map.

B. Identify two (or more) prominent terrain features(A and B) and locate these on your map.

C. Take compass sightings on features A and B; convert to grid azimuths.

D. Plot back grid azimuths from A and B toward your position on the map.

E. Intersection of the back azimuths on your map pinpoints your previously unknown position (X).

PART V

RELIEF

Set 5-1. CONTOUR LINES AND ELEVATION

FRAME 1.

The differences in shape and height of the earth's surface are called relief. On a map, relief is shown by symbols called contour lines. Contour lines show the ________________ (differences in heights) of the ground.

(less, supplementary) (19)

FRAME 20.

Supplementary contours are shown by **dashed lines** on the map. Refer to the marginal information (bottom center) on the LEAVENWORTH map. What is the interval at which supplementary contours are drawn?

a. 5-foot b. 10-foot c. 20-foot

(960 feet) (38)

FRAME 39.

Often, the point whose elevation you wish to determine falls between the contour lines shown on the map. If it falls in the middle or close to the middle of the space between contours, you give it the value that is halfway between the contours. If it is closer to the lower or upper contour, you give it the value of the closest contour. If another road junction were halfway between the 960- and 980-foot contour lines (horizontal distance) it would be considered halfway between the 960- and 980-foot elevations (vertical distance) or at an elevation of ______________.

(profile) (57)

FRAME 58.

Step 2. Find the value of the highest and lowest contour lines that cross or touch the profile line. In Panel 5-13 what is the higest contour elevation, and what is the lowest?

Highest	**Lowest**
a. 540	a. 400
b. 600	b. 420
c. 640	c. 460

(relief) (1)

FRAME 2.

On the map, relief (changes in height and shape of the ground) is pictured by the brown lines called **contours** or **contour lines.** Since a hill is a relief feature, it is shown on the map by ________________.

(b. 10-foot. Note: Supplementary contours are usually added at one-half the contour interval.) (20)

FRAME 21.

Each contour line, whether index, intermediate or supplementary, represents the same elevation wherever it appears on the map. In other words, all points on a contour line are at the same ________________.

(970 feet) (39)

FRAME 40.

Spot elevations and bench marks (identified in the legend of your LEAVENWORTH map) are elevations which have been measured by surveyors or map makers at prominent locations, such as road junctions and hilltops. Along the south edge of the LEAVENWORTH map, the number 946, between grid lines 31 and 32, refers to a road junction. This is the ________________ of the junction.

(b. 600, c. 460) (58)

FRAME 59.

Step 3. Add one contour interval value to the highest and subtract one value from the lowest contour elevation. This will take care of the hilltops and draws. The contours to be drawn in the profile, including the added and subtracted values, range from ______ to ______.

a. 400, 600 **b.** 420, 640 **c.** 440, 620 (contours) (2)

FRAME 3.

Refer to coordinates 4152 on your LEAVENWORTH map. Note the many brown ____________ ____________ which indicate hilly terrain.

(elevation) (21)

FRAME 22.

The contour interval is the **vertical distance** represented between one contour and the next one to it. Whatever the horizontal distance between the two contours, the vertical distance between them is the ____________.

(elevation) (40)

FRAME 41.

Prominent features (hilltops, road junctions) may be referred to by their elevations. For example, the hill at grid coordinates 485536 on the LEAVENWORTH map could be called which of the following?

a. hill 967 b. hill 769 c. RJ 970

(c. 440, 620) (59)

FRAME 60.

Step 4. Place a sheet of lined paper along the profile line with the lines parallel to the profile line (Panel 5-14). (Graph paper may be used or uniformly spaced lines drawn on a blank sheet.) A line is needed for each contour between the values determined in step 3. Including lines for the 440 and 620 contours how many are needed for the profile? (Panel 5-14)

a. 6 b. 8 c. 10

5—6

(contour lines) (3)

FRAME 4.

A contour line stands for height above a certain level called base plane or datum. Thus, a 960-foot contour line means it is 960 feet above the ____________.

Set 5-2. DETERMINING GROUND SHAPES FROM CONTOUR LINES

(same) (22)

FRAME 23. INFORMATION FRAME.

You can determine ground shapes — the size and shapes of hills and valleys, steepness of slopes, and related terrain conditions — by studying the **shapes** and **patterns** of the contour lines. A careful examination of the contour lines on the map is therefore necessary to properly "see" the terrain in which you intend to operate. This would enable you, for example, to avoid excessively steep slopes and other hindrances to your actual travel on the ground, and to avoid locating bivouacs and vehicle parks in areas subject to flooding.

Set 5-4. COMPUTING SLOPE

(a. hill 967) (41)

FRAME 42. INFORMATION FRAME.

You will recall that when you learned about contours, you saw that contour spacing on your LEAVENWORTH map indicated the type of slope. Closely spaced contours, for example, represented a steep slope. The steepness of slopes is obviously very important in planning the movement of a unit, since steepness affects mobility, concealment, use of plunging fire, etc. In the next few frames, you will learn how to compute accurately the slopes or gradients of the ground on which your unit may have to operate.

(c. 10. The difference in elevation (620-440) is 180 feet or nine 20-foot intervals. It will require 10 lines to show these nine intervals.) (60)

FRAME 61.

Step 5. Starting with the lowest value at the bottom, label each line consecutively with its proper contour value (Panel 5-14). You will have 10 labeled lines ranging from __________ to __________.

a. 440 - 620　　b. 460 - 600　　c. 480 - 580

(datum (base plane)) (4)

FRAME 5.

The datum used on military maps is **mean sea level** (average sea level). The 960-foot contour, no matter on which map it is drawn, is always 960 feet above

________ ________ ________.

(Go on to the next frame) (23)

FRAME 24.

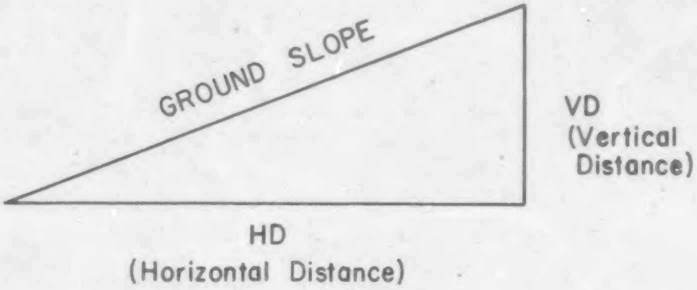
Peaks or hilltops (Panel 5-2) are easily identified because the contours close to form concentric circles, ovals, or loops. Remember, contours forming concentric loops depict ________________.

(Go on to next frame) (42)

FRAME 43.

Ground slope is a ratio of vertical distance to horizontal distance or $\frac{\text{vertical distance}}{\text{horizontal distance}}$. This ratio expressed as a simple fraction is called a gradient.

The gradient is one way of expressing ____________________.



(a. 440-620) (61)

FRAME 62.

Step 6. Mark the position of the starting and finishing points (A and B) on the edge of the lined paper (Panel 5-14). (Include any of the points with known elevations, such as road junctions.) In effect, you have marked the distances between these points on the paper's edge. This corresponds to which distance between the points?

a. horizontal **b.** vertical

(mean sea level) (5)

FRAME 6.

On maps, the vertical distance or height above mean sea level is called **elevation.** The 960-foot contour, being 960 feet above mean sea level, is 960 feet in

____________________.

(hills (peaks or hilltops)) (24)

FRAME 25.

Contour lines that show a relatively low point, frequently between two hilltops, along a formation of high ground indicate a saddle (Panel 5-3). As a general rule, a ____________________ is a noticeably low spot along the crest of a high formation.

(slope) (43)

FRAME 44.

To compute gradient, the horizontal and vertical distance must always be the same units of measure such as feet, yards, or meters. When the slope is expressed as a fraction ($\frac{VD}{HD}$ in the same units), it is called a __________________.

(a. horizontal) (62)

FRAME 63.

Step 7. From the starting and finishing marks, draw perpendiculars straight down across the horizontal lines to their elevations as indicated by the spaced and labeled lines. Mark these elevations with a dot. For example, the starting point, A, (Panel 5-15) has an elevation of 538 feet. The perpendicular should be marked between the 520 and 540 lines at an elevation of ________________ feet.

(elevation (Note: In mapping, elevation is height above mean sea level, whereas in artillery, elevation is a vertical angle or angular height from a horizontal plane.)) (6)

FRAME 7.

Refer again to coordinates 4152 on your LEAVENWORTH map and you will find 900 printed in brown on a contour line. This means that the 900-foot contour being 900 feet above mean sea level is 900 feet in __________________.

(saddle) (25)

FRAME 26.

A ridge is a formation of high ground, often consisting of a series of connected peaks and saddles. The ridge "line" follows the backbone, or highest points, through the formation (Panel 5-4). Contours cross the imaginary ridge "line" at right angles and turn back to parallel the ridge line. The series of connected peaks and saddles along the backbone of a formation of high ground defines a __________.

(gradient) (44)

FRAME 45.

The contour interval (vertical distance two contours) is 20 feet. The horizontal distance between the same two contours measures 100 feet. The gradient (ground slope) between these contours is $\frac{20 \text{ feet}}{100 \text{ feet}}$ or $\frac{1}{5}$. What is the gradient if the horizontal distance between the contours increases to 600 feet?

a. $\frac{1}{5}$

b. $\frac{1}{30}$

c. $\frac{1}{600}$

---

(538) (63)

FRAME 64.

Step 8. At **each contour line** crossing or touching the profile line, draw a perpendicular to its corresponding elevation and mark this point (Panel 5-15). The profile will cross through all the marked points and shows the ____________ view of the ground (not to scale).

(elevation) (7)

FRAME 8.

Refer to grid square 2852 on your LEAVENWORTH map and you will find another contour whose height is printed in brown on the contour line. The elevation of the contour is ____________ feet.

(ridge) (26)

FRAME 27.

A protrusion or extension from a hill or ridge into lower ground is a **spur.** The contours follow around the spur in a U-shape with the U pointing downhill (Panel 5-4). The distinguishing characteristic of a spur is the contour pointing downhill in a ___________ shape.

a. V b. U c. M

(b. $\frac{1}{30}$. $\frac{VD}{HD} = \frac{20 \text{ feet}}{600 \text{ feet}} = \frac{1}{30}$) (45)

FRAME 46.

Slope can also be expressed as a percent or $\frac{VD}{HD} \times 100$. The $\frac{1}{30}$ gradient of the last frame equals $\frac{1}{30} \times 100$ or 3.33 percent slope. What is the percent slope of the 100-foot spacing in the previous frame?

a. 5 b. 20 c. 33

(side) (64)

FRAME 65.

Step 9. The higher points along the profile line will be the hilltops and ridges. The lower points will be the draws and depressions. Mark the positions of each one and draw the perpendiculars across the horizontal lines to their elevation points on the ruled spaces. (See Panel 5-16.) The profile will change direction (up to down or vice versa) at these critical points which define the ________________ and ________________ points along the profile.

(1000) (8)

FRAME 9. INFORMATION FRAME.

Refer to grid square 2852 again. You see that there are many other contour lines besides the one you found to be 1000 feet in elevation. You will now learn how these other contour lines show changes in elevations. Each of **these contour lines, though not numbered,** also represents a **specific** ground elevation. On the LEAVENWORTH map, each change of elevation of 20 feet is shown by a solid contour line.

(U) (27)

FRAME 28.

As contour lines approach **draws** (beds of running or dry streams), they turn upstream and run along the sides until they cross. Contours cross draws and turn back in a characteristic V shape with the V pointed upstream (Panel 5-5). To identify a draw, you must locate the upstream pointing of the ______________ contours.

a. V-shape. b. U-shape. c. M-shape.

(b. 20. $\frac{20}{100} \times 100 = 20$ percent slope) (46)

FRAME 47.

Refer to your LEAVENWORTH map. You want to find the percent of slope of the ground between the dirt road junction at 482534 and hilltop 967 to the northeast. You must determine first the __________________ distance and the __________________ distance between the points.

(higher, lower) (65)

FRAME 66.

Step 10. Connect all marked points with a smooth natural curve. (See Panel 5-17.) The curve will change direction at the perpendicular lines indicating high and low points. At the hilltops (ridges) the curve will be smooth and rounded, while in the draws it will turn back in the form of a ___________ shape.

a. U

b. V

c. M

(Go on to next frame) (9)

FRAME 10.

Look at Panel 5-1. It shows a horizontal plane cutting through a hill. The line marking all the points where this plane cuts the hill is at the same elevation. It is called a ________________ line.

(a. V-shape) (28)

FRAME 29.

In mountains or hills of higher elevations, draws are narrow but as they reach lower elevations, they become larger and are often wide enough to permit at least limited maneuvering of a military unit. These wide portions are called valleys (Panel 5-5). The ________________ retain the V-shape characteristics of a draw.

(vertical, horizontal) (47)

FRAME 48.

Use the edge of a sheet of paper to measure the horizontal distance. Transfer this measurement to the bar scale (in YARDS) and read the number of yards. Multiply the yard reading by 3 and you have the horizontal distance in feet. What is the approximate distance?

a. 85 b. 500 c. 1400

(b. V) (66)

FRAME 67.

For a hasty profile, only the contours identifying the high and low points are plotted. (See Panel 5-18.) The remainder of the profile is completed by joining these points. The high and low points identify which map features?

a. ridges and draws b. road crossings c. woods lines

(contour) (10)

FRAME 11.

A contour line drawn above or below the first one would be at a different elevation. The contour interval is the difference in ________________ between adjacent contour lines. If 1000-foot and 980-foot contours are adjacent contours on a map, the contour interval is ________ feet. (Panel 5-1) The next lower contour line going down towards a stream or draw would be ______________.

(valleys) (29)

FRAME 30.

A large hole, sink, or depression in the ground (Panel 5-6) is shown by a closed loop contour. Ticks are added inside the loop to indicate that the lower ground is inside the contour. When ticks appear along a contour, they indicate that the ground on that side of the contour is ________________.

(1400. The distance measures about 470 yards on the bar scale and therefore approximately 1400 feet) (48)

FRAME 49.

For the vertical distance, start with the road junction. It falls halfway between the 900- and the 920-foot contours, or at ____________ feet.

(a. ridges and draws) (67)

FRAME 68.

The profiles just completed can be exaggerated in a vertical direction depending upon the spacing between the parallel horizontal lines. This exaggeration may be varied to suit any purpose by changing the ______________ of the lines.

(elevation, 20 (1000 - 980 (difference in elevation) equals 20 feet) (960)) (11)

FRAME 12.

No matter how far apart two adjacent contours are drawn on the map, the contour interval defines the difference in ____________________ between these two lines.

(lower) (30)

FRAME 31.

Roads and railroads are cut through hills and spurs and are built on fills across draws and low places (Panel 5-7). On a map, cuts are indicated by solid brown lines that are parallel to adjacent roads, railroads, or other manmade features. Fills are also indicated by ____________________ lines adjacent to roads, railroads, or other ____________________ features but have ticks added to indicate the direction of lower ground.

(910) (49)

FRAME 50.

The measured elevation above sea level of the top of the hill (967 feet) is shown on the map. To find how high the hill is above the surrounding terrain (vertical distance), subtract the elevation of the bottom of the slope at the crossroads (910 feet) from the elevation of the top of the hill (967 feet). The vertical distance is ________________ feet.

Set 5-6. USE OF PROFILE TO SHOW AREAS OF CONCEALMENT

(spacing) (68)

FRAME 69.

Profiles are used to determine where friendly and enemy forces are intervisible (can see each other). The high points will block the view or line of sight, and anything behind the ______________ points will not be seen.

(elevation) (12)

FRAME 13.

Refer to the marginal information (bottom center) of the LEAVENWORTH map. What is the contour interval for this map?

a. 5 feet b. 10 feet c. 20 feet

Set 5-3. SLOPE

(parallel) (manmade) (31)

FRAME 32.

The horizontal spacing between two adjacent contours represents the **horizontal distance** between the two elevations on the ground. (See Panel 5-8.) The slope of the ground between two contours is "pictured" by the contour interval (vertical distance) and the spacing or ________________ distance.

(57 feet) (50)

FRAME 51.

The vertical distance from the hilltop to crossroads is 57 feet. The horizontal distance between the hill and crossroads you found to be 1400 feet. The slope of the hillside is $\frac{VD}{HD}$, or $\frac{57\text{ feet}}{1400\text{ feet}}$. What is the percent slope?

a. $\frac{1}{25}$ b. 2.5 c. 4

(high) (69)

FRAME 70.

Refer to Panel 5-12. Profile A has an observation point at the left with the line of sight drawn over each intervening high point. The shaded areas behind the hills and under the line of sight are ________________ (since a line of sight is always a straight line).

a. visible b. invisible

(c. 20 feet) (13)

FRAME 14.

Each plane represents contours at a different elevation, and the distance or interval between planes is the ______________ ______________ (Panel 5-1).

(horizontal) (32)

FRAME 33.

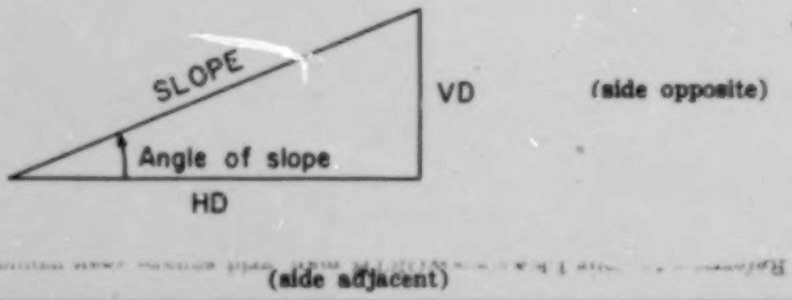
Contour patterns indicate steepness of ground slope. (Panel 5-9) Widely spaced contours indicate a gentle ____________. Steep slope is indicated by ________ spaced contours.

(c. 4. $\frac{57}{1400} \times 100 = 4$ percent) (51)

FRAME 52.

Slope can also be expressed as an angle or "degree of slope" (see sketch). The gradient converted to a decimal is the tangent of the slope angle. For example, $\frac{1}{5} = 0.2$, expressed as a decimal. This value, 0.2, is the tangent of the slope angle or ____________ of slope and is found in a table of trigonometric functions.

The tangent of the angle of slope $= \frac{\text{side opposite}}{\text{side adjacent}} = \frac{VD}{HD}$.



(b. invisible) (70)

FRAME 71.

The shaded areas (Panel 5-12) also can tell you heights of objects which will be concealed. You measure these heights from the contour line values on your profile. Shaded areas show the ________________ of objects that can be concealed.

(contour interval) (14)

FRAME 15.

Contour lines are drawn as brown lines on the map. Every **fifth** line (starting from zero elevation) is made heavier and is called an **index** contour. Printing the ____________________ contours as heavier lines makes the map easier to read.

(slope, closely) (33)

FRAME 34.

Referring to your LEAVENWORTH map, grid square 2849 would appear to have _______________ slopes compared to the slope in most of the area in grid square 2949.

(degree) (52)

FRAME 53.

If you consult a table of trigonometric functions, you find that .2 is the tangent of 11° 20′. **Approximate** slope angle or degree of slope can also be calculated without the use of the tables. Multiply the gradient by 57.3 and the result is the approximate angle of slope in degrees. For example, $\frac{1}{30}$ gradient = $\frac{1}{30} \times 57.3 = 1.9$ or 2° of slope when rounded off. What is the approximate slope in degrees if the gradient is $\frac{1}{5}$?

a. 5 b. 8½ c. 11½

(heights) (71)

FRAME 72.

The **extent** of the hidden area (in a **horizontal** direction) is determined by transferring the shaded area points back to the map. Several profiles radiating from the observation point will define the ________________ of the area hidden (Panel 5-12).

(index) (15)

FRAME 16.

As you have seen, the LEAVENWORTH map has a contour interval of 20 feet which indicates a difference in height of 20 feet between contours. You note from your map that the index contours (every fifth contour) are the _________ foot contour lines.

(gentle) (34)

FRAME 35.

Evenly spaced contours indicate a uniform slope (Panel 5-10). If they are closely spaced, they represent a __________________ uniform slope; if widely spaced, a __________________ uniform slope.

(c. 11½. $\frac{1}{5} \times 57.3 = 11\frac{1}{2}$ degrees of slope. Note: This method is reasonably accurate up to 20 degrees of slope.) (53)

FRAME 54.

Slope may be rising (up) or falling (down), and a plus or minus, respectively, is added. The slope of a road is 3 percent from elevation 500 to elevation 580. How is this expressed?

a. +3 percent

b. −3 percent

(extent) (72)

FRAME 73.

Using the heights of the hidden area (defilade) from the profile, a commander can select the best route to cover the movement of troops and equipment. On profile A, Panel 5-12, how many of the three draws will safely hide vehicles and troops?

a. 1

b. 2

c. 3

(100) (16)

FRAME 17.

Again on your LEAVENWORTH map, what are the two index contours shown in grid square 2852 and grid square 2850 respectively?

(steep, gentle) (35)

FRAME 36.

Change in contour spacing along a slope also indicates a type of slope. Closely spaced contours (steep slope) at the top and wider spacing (gentle slope) at the bottom (A, Panel 5-10) represent a ____________________ slope. Wide spacing (gentle slope) on top and close spacing (steep slope) near the bottom (B, Panel 5-10), indicate a ____________________ slope.

Set 5-5. CONSTRUCTING A PROFILE

(a. +3 percent. This slope is up or rising from 500 to 580. In the other direction, the slope from 580 to 500 is minus (down or falling) (54)

FRAME 55. INFORMATION FRAME.

A profile or side view (cross section) of the ground along a selected line or direction can be used to determine where friendly and enemy forces are intervisible (can see each other). Certain high points might block the view or line of sight from one point to another. The next few frames will show you how to construct a profile of the ground from the contours shown on your map for the same area (see Panel 5-12).

Set 5-7. ADDITIONAL MAP TECHNIQUES WHICH SHOW RELIEF

(b. 2) (73)

FRAME 74.

Hachures are short brown lines or ticks drawn in a pattern to represent land forms (relief). The length and spacing of the ticks create a picture of the slopes, but do not indicate amounts. Hachures, added to contour maps, show detail too small to be indicated by the contour interval. What other brown line symbols do hachures replace in this case?

a. index contours b. intermittent streams c. supplementary contours

(1000, 1100) (17)

FRAME 18.

The four contour lines between index contours are called **intermediate contours.** The brown line is **thinner** than the index contour, and usually elevations are not shown on these lines. The **thin** lines between index contours are called the ______________ contours.

(concave, convex) (36)

FRAME 37.

As the ground slope increases in steepness, the contours appear closer together. On a vertical slope or cliff, there is no horizontal spacing between contours (Panel 5-11). They appear as a single line. When contours on a map run into a single line, the ground formation is a ______________.

(Go on to the next frame) (55)

FRAME 56.

A profile can be constructed between any two points on a contour map. For example, the slopes of a road between road junction 538 A and road junction 520 B in Panel 5-13 are required. The profile along this line (Panel 5-13) will show all the ________________.

(supplementary contours) (74)

FRAME 75.

Relief may also be indicated on maps by **layer tinting, shaded relief,** and **form lines.** These methods are described in FM 21-26. Like hachures, these methods indicate only specific qualities of the land forms, such as size or extent. Measurements of the relief, such as slopes and elevation differences, cannot be made as with ________________.

(intermediate) (18)

FRAME 19.

In relatively flat terrain areas, relief changes are gradual so that the contour interval (20 feet for LEAVENWORTH map) may be too great to show critical landforms. **Supplementary contours** are added in these areas only, to show the changes of _______________ than 20 feet. When _______________ contours are used, an explanatory note is placed in the margin.

Turn back to bottom of page 5-1 for frame 20

(cliff) (37)

FRAME 38.

Contours also provide elevation information for the locations on a map. A 960-foot contour passes through all points which are 960 feet in elevation. If the 960 contour passes through a road junction, the elevation of the road junction is ___________________.

Turn back to top of page 5-2 for frame 39

(slopes) (56)

FRAME 57.

Frames 5-57 through 5-67 discuss the steps in constructing a profile. Refer to Panel 5-13 in studying the steps to follow.

Step 1. Connect the two points, A and B, with a straight line (Panel 5-13). This is the profile line. The side view of the slopes will be shown along this ________________ line.

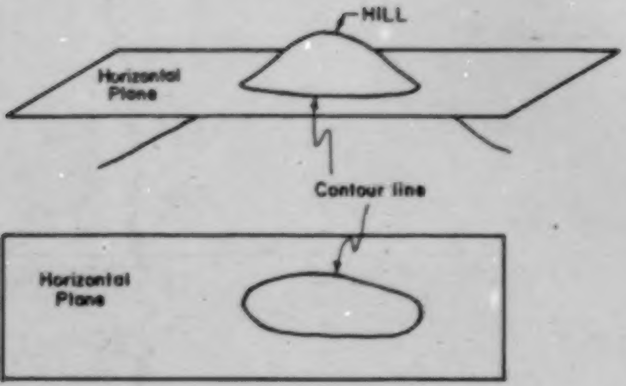
Turn back to bottom of page 5-2 for frame 58

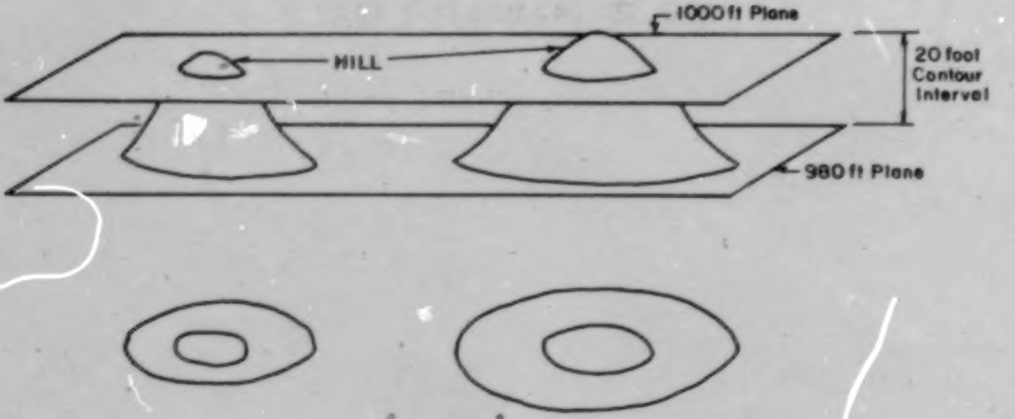
(contours) (75)

END OF FRAMES FOR PART V

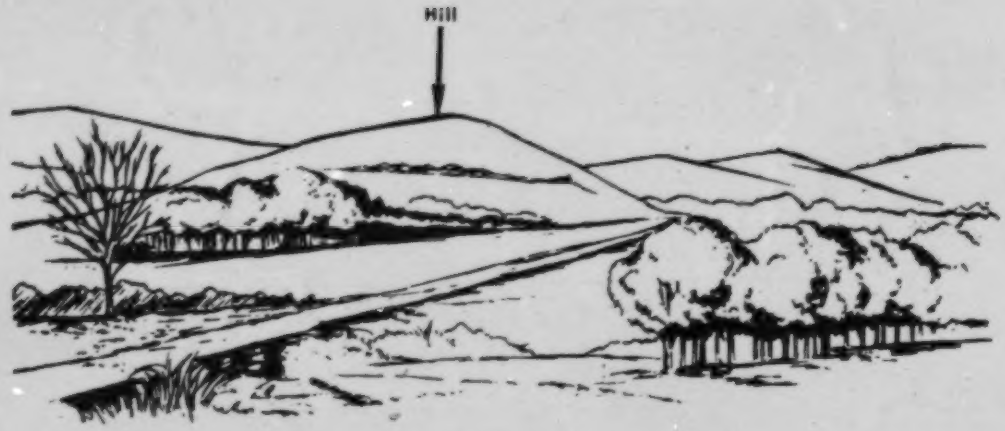
PANEL 5-1

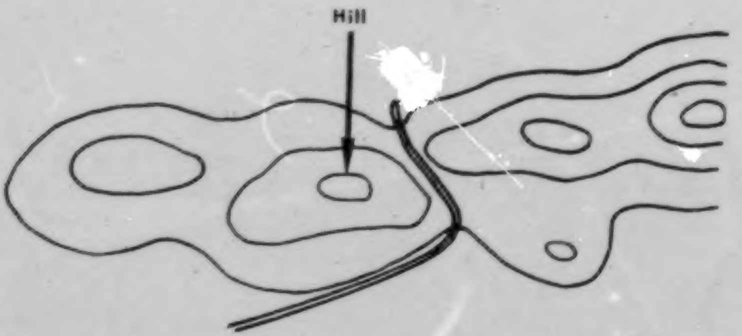
CONTOUR LINES AND INTERVALS


HILL
Horizontal Plane
Contour line
Horizontal Plane

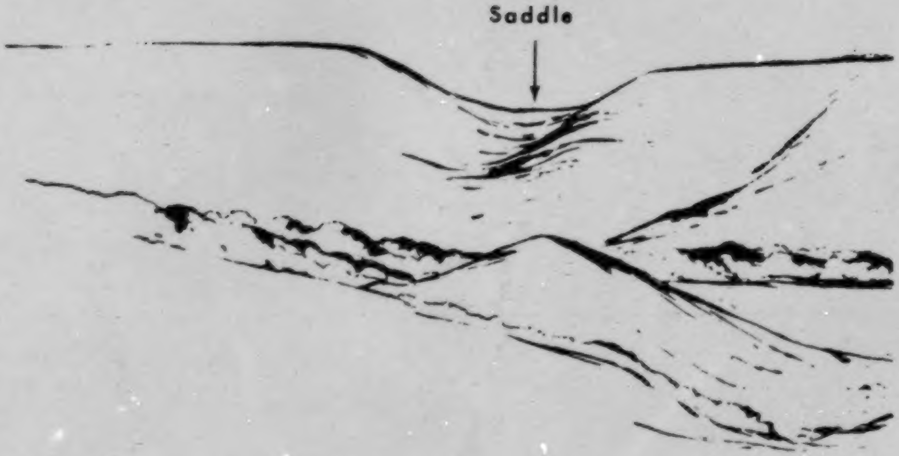

1000 ft Plane
HILL
20 foot Contour Interval
980 ft Plane

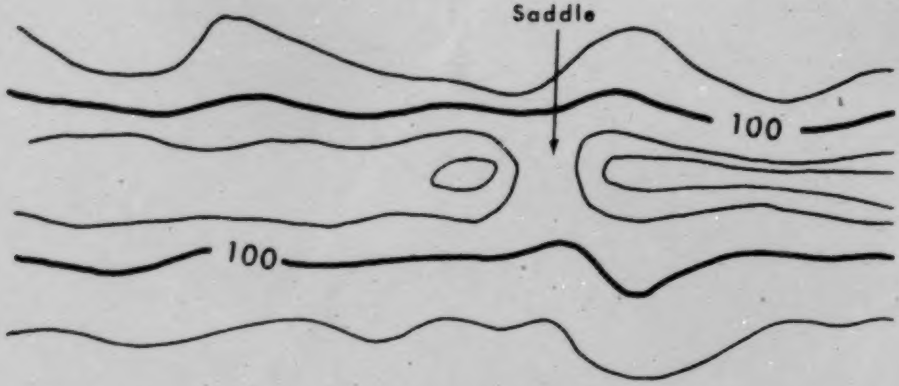
PANEL 5-2 — HILL



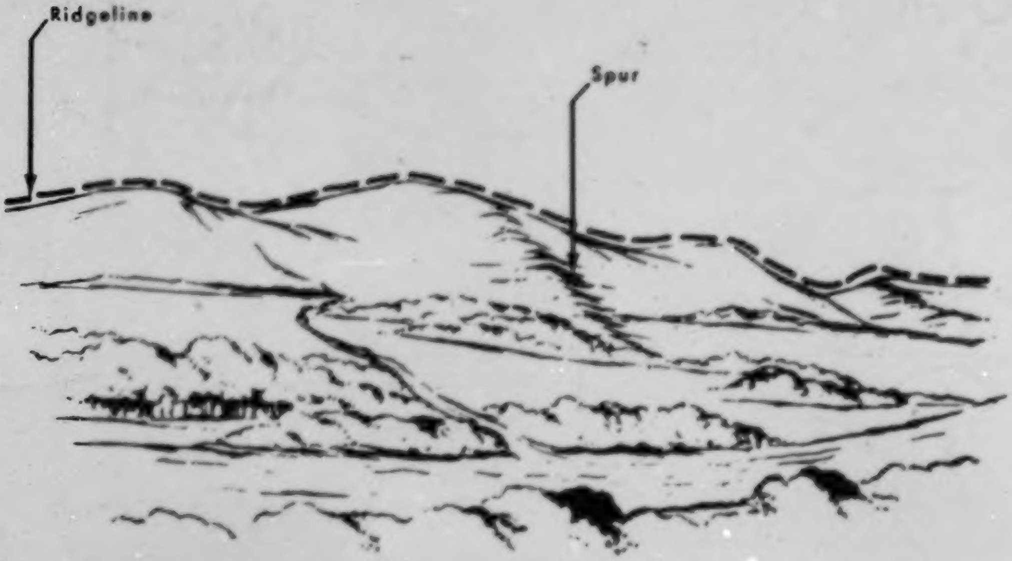


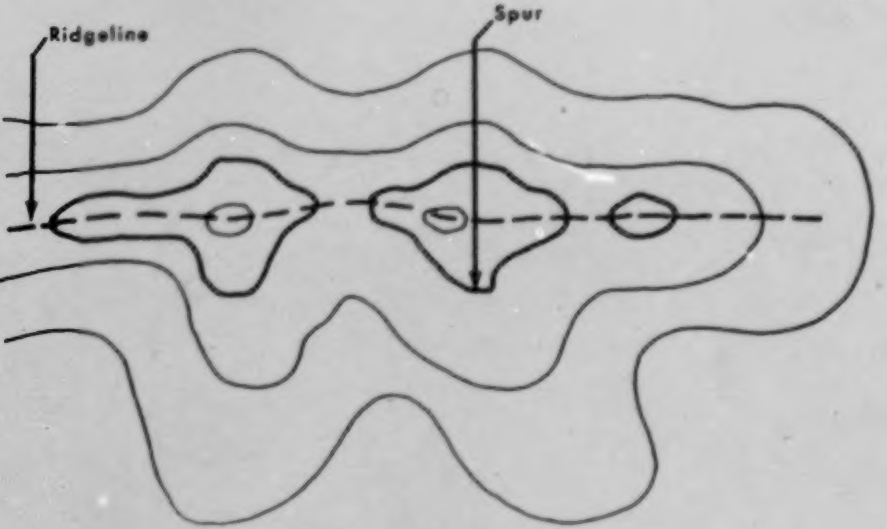
PANEL 5-3 — SADDLE



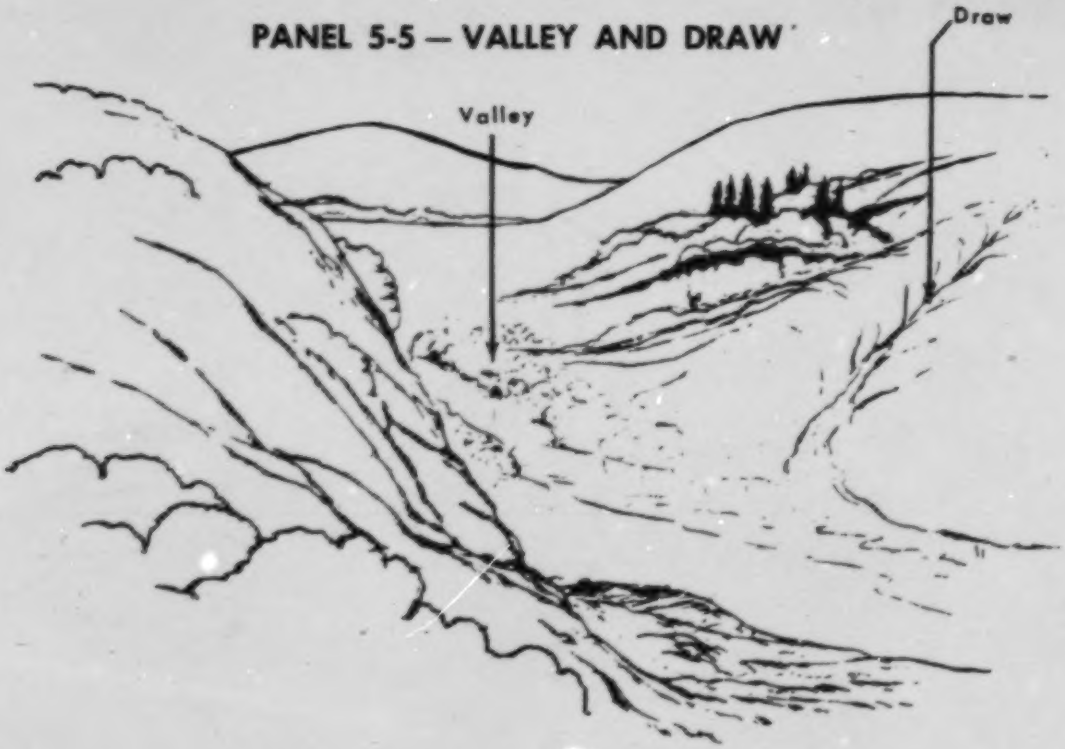

Saddle
100
100

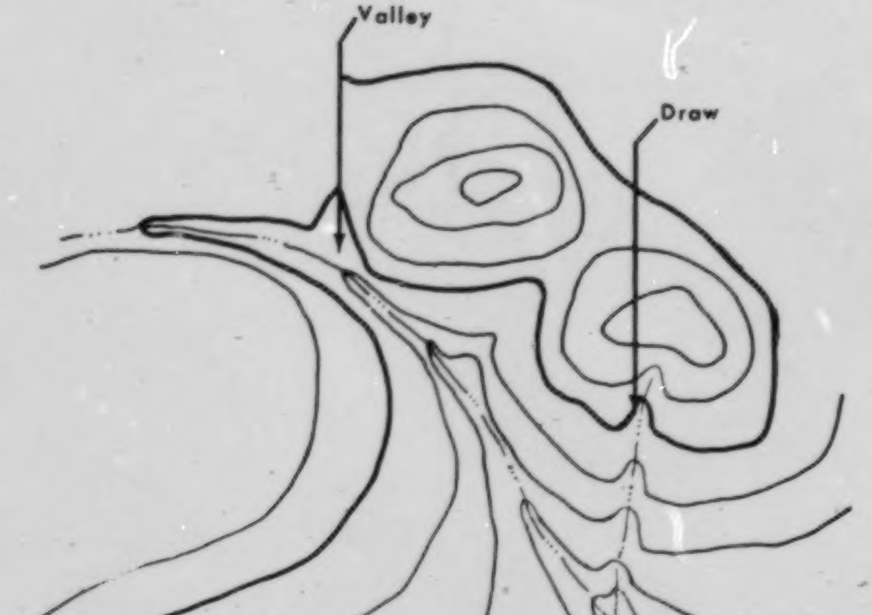
PANEL 5-4 — RIDGE AND SPUR


Ridgeline
Spur

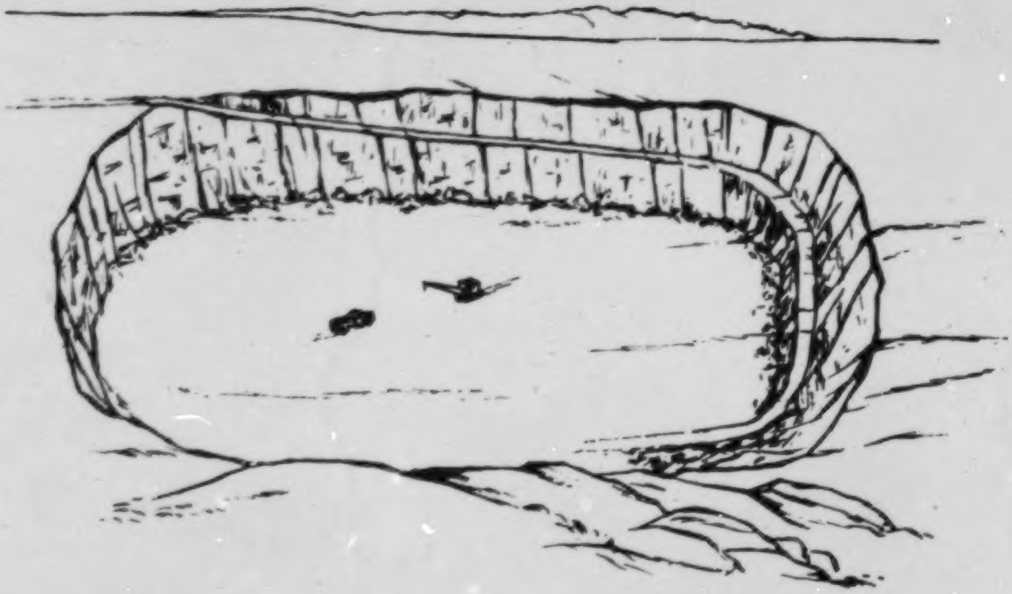

Ridgeline
Spur

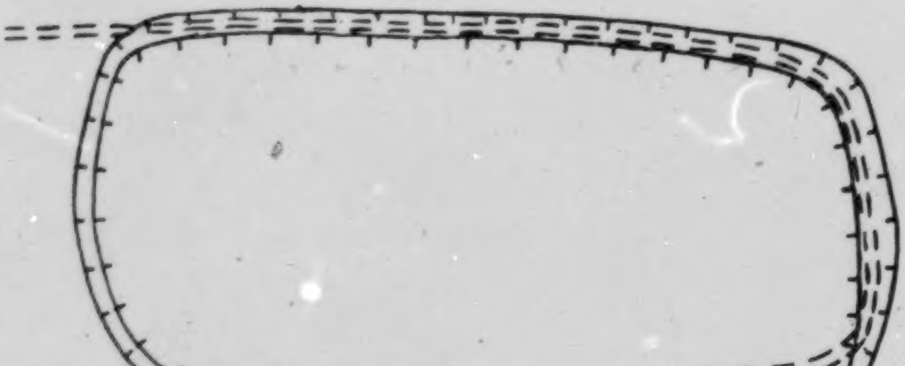
PANEL 5-5 — VALLEY AND DRAW


Draw
Valley

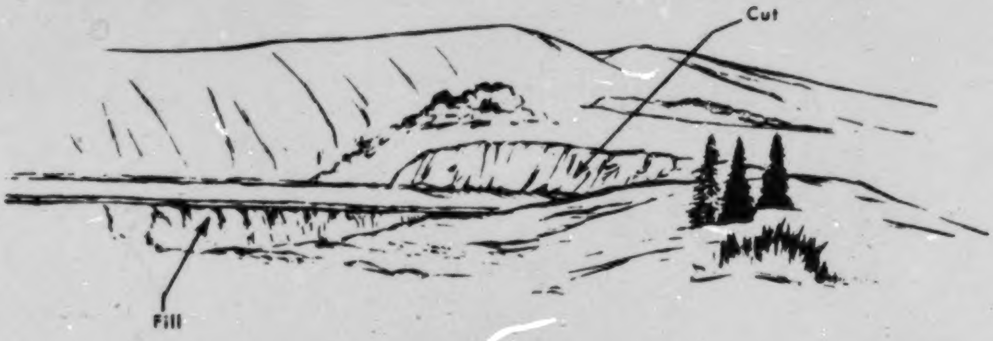

Valley
Draw

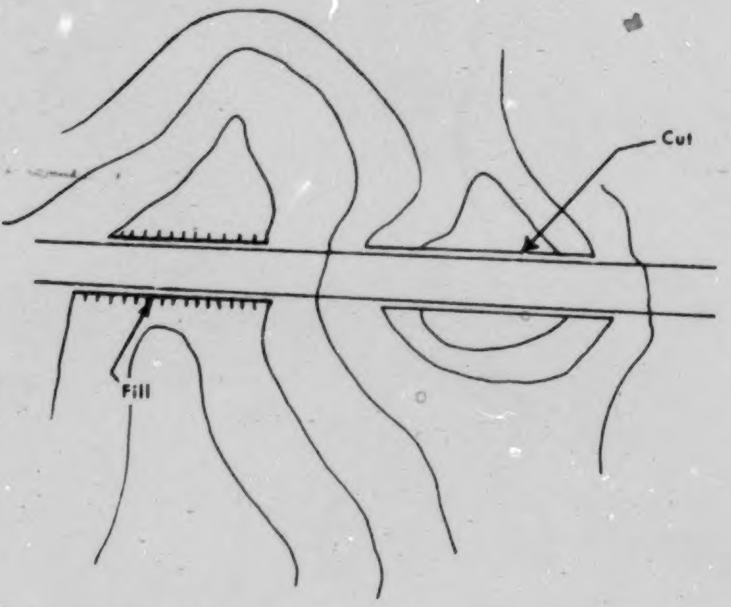
PANEL 5-6 — DEPRESSION





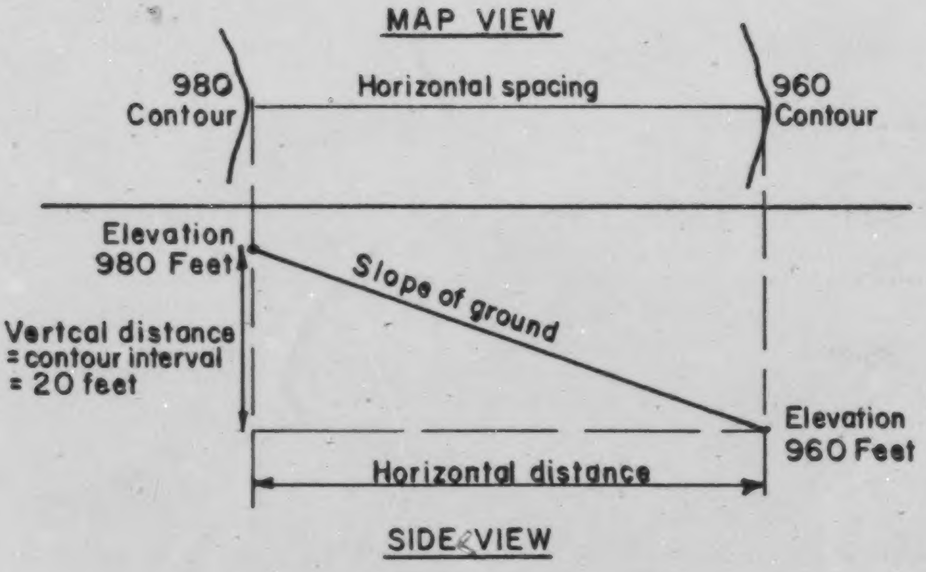
PANEL 5-7 CUT AND FILL





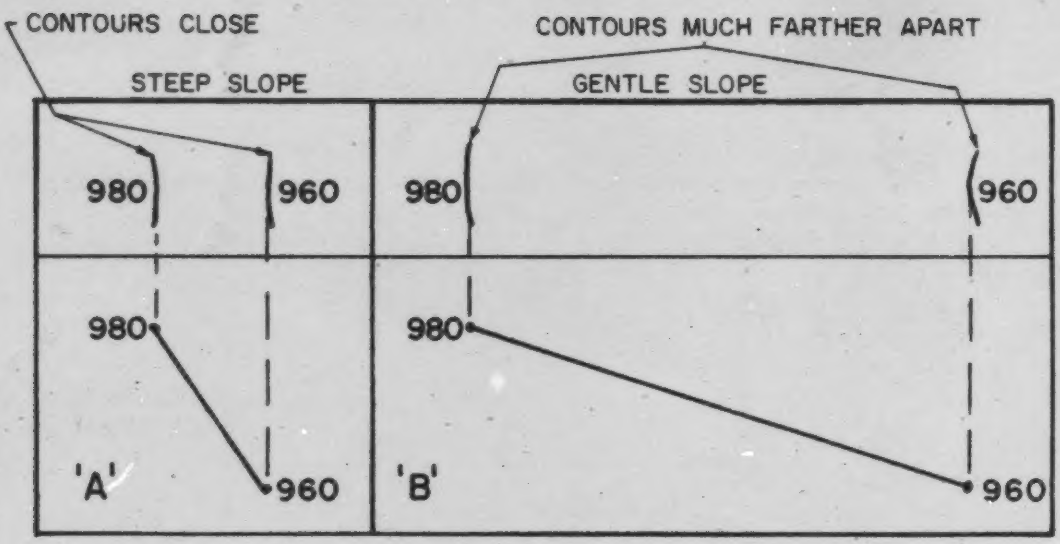
PANEL 5-8

CONTOUR LINE AND ACTUAL SLOPE OF THE GROUND

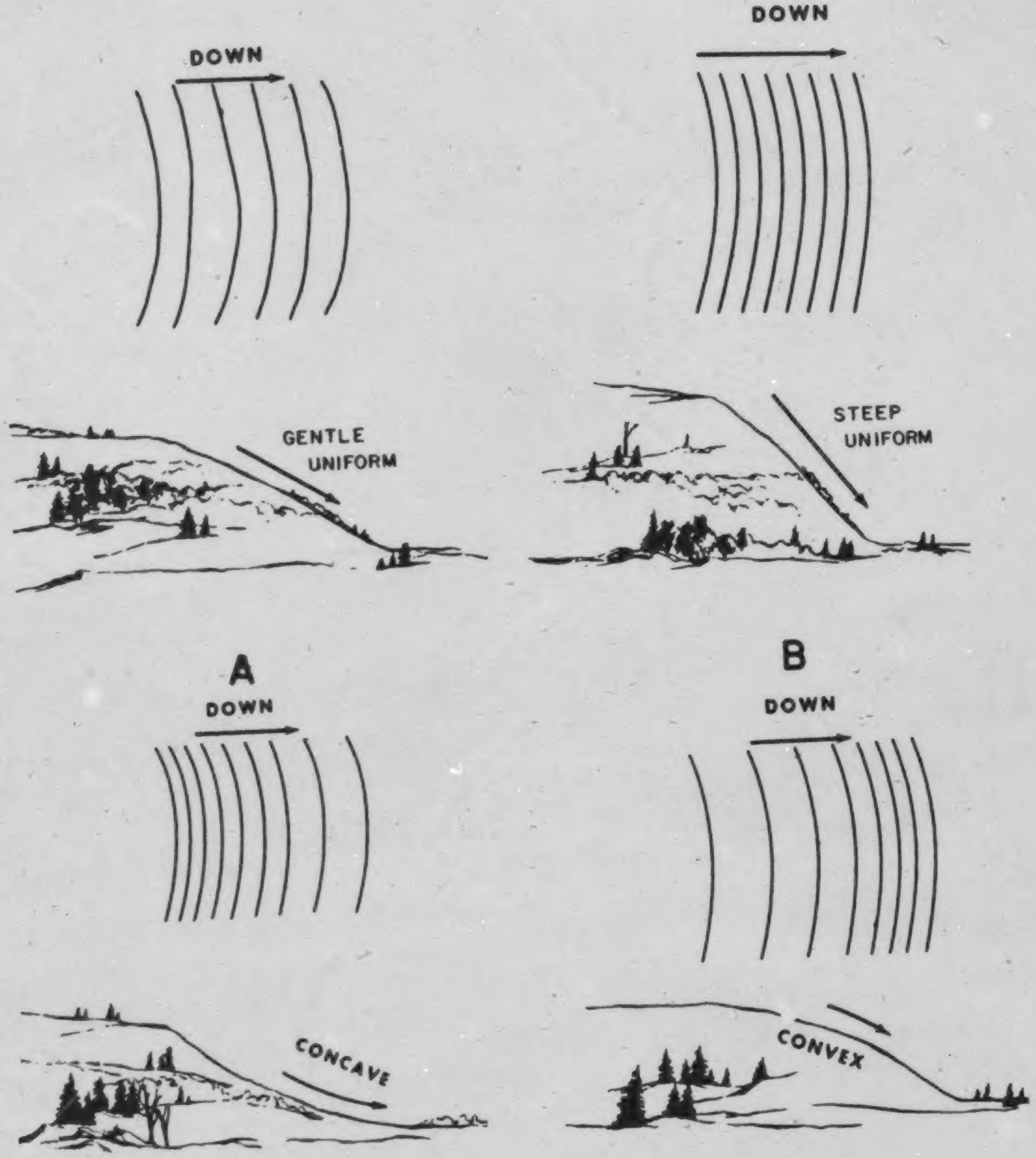

MAP VIEW
980
Contour
Horizontal spacing
960
Contour
Elevation
980 Feet
Slope of ground
Vertcal distance
=contour interval
= 20 feet
Elevation
960 Feet
Horizontal distance
SIDE VIEW

PANEL 5-9

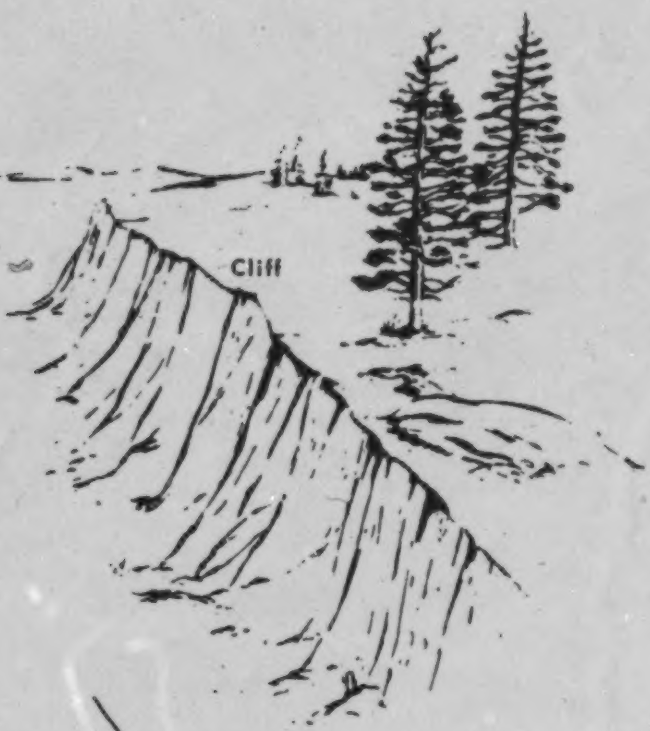
CONTOUR SPACING AND SLOPE OF THE GROUND

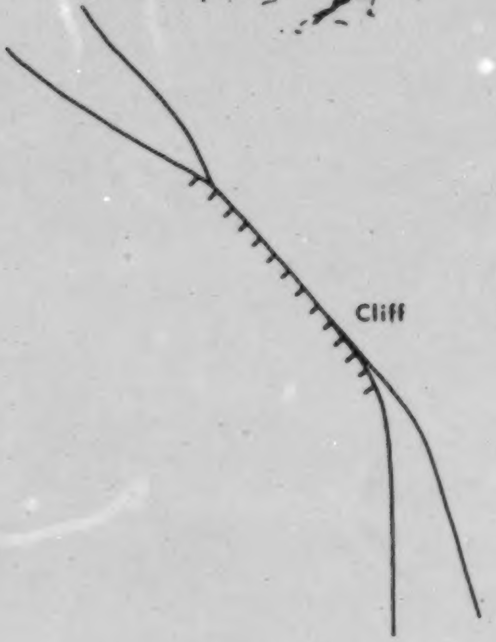

CONTOURS CLOSE
STEEP SLOPE
CONTOURS MUCH FARTHER APART
GENTLE SLOPE
980
960
980
960
980
960
980
960
'A'
'B'

PANEL 5-10 — SLOPES


DOWN
GENTLE UNIFORM
DOWN
STEEP UNIFORM
A
B
DOWN
CONCAVE
DOWN
CONVEX

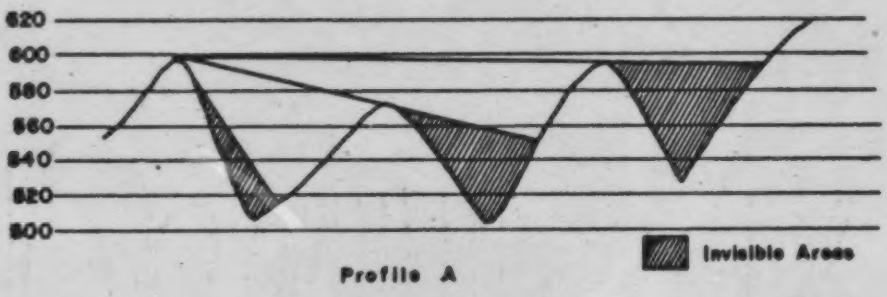
PANEL 5-11 CLIFF

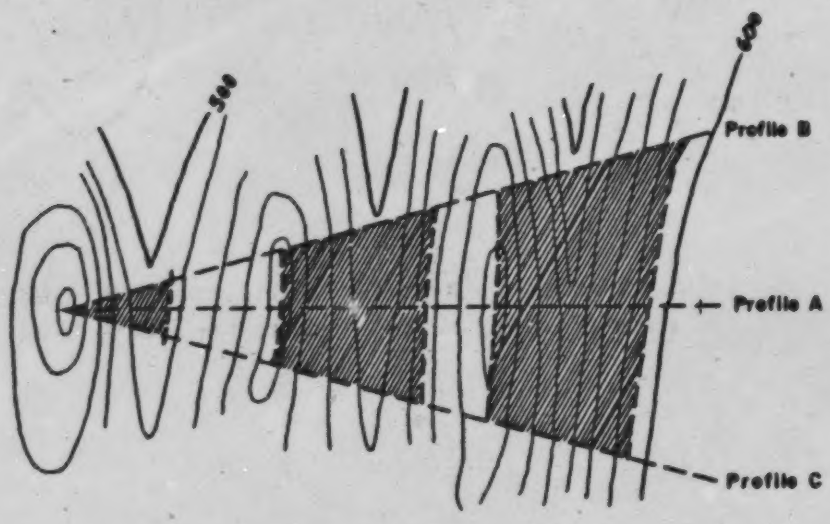




PANEL 5-12

PROFILE WHICH SHOWS VISIBLE AND INVISIBLE AREAS



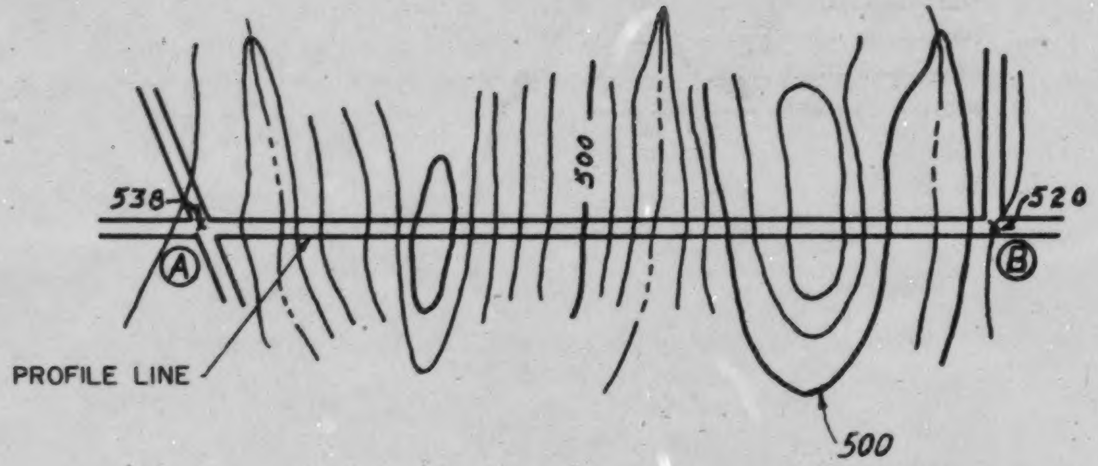

580
600
Profile B
Profile A
Profile C

INVISIBLE AREAS TRANSFERRED TO MAP

NOTE: Intervisibility cannot be determined from a profile based on contours alone. Heights of trees and other intervening objects must be taken into account.

PANEL 5-13

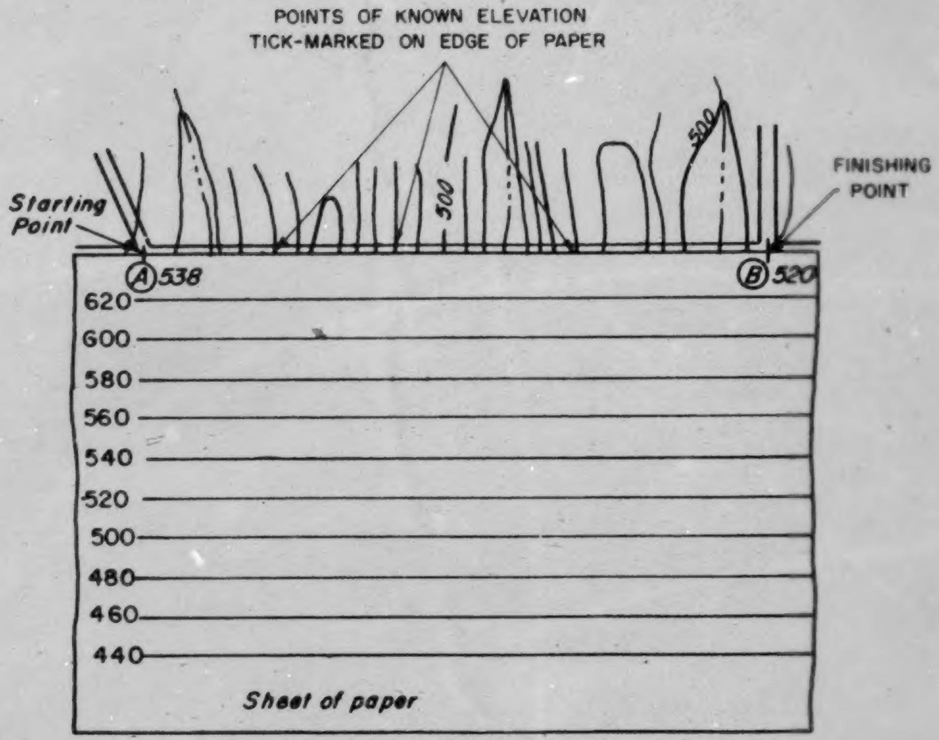
CONSTRUCTING A PROFILE


538
520
A
B
500
PROFILE LINE
500

Slopes (contours) between two points (road junctions) on a road. The straight road can be used as the profile line.

PANEL 5-14

CONSTRUCTING A PROFILE (Continued)

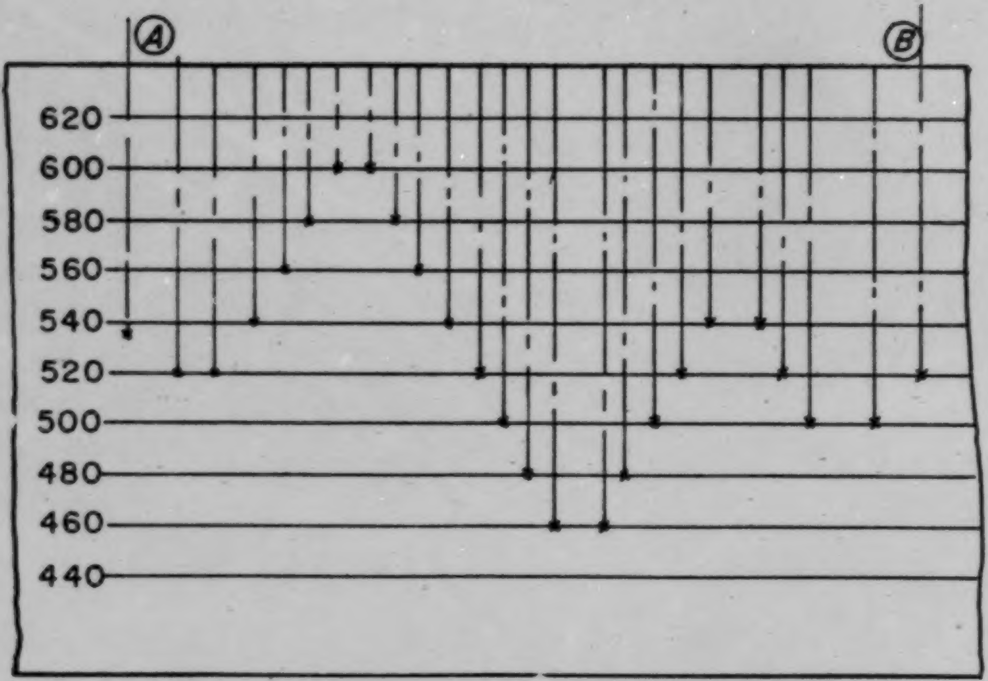

POINTS OF KNOWN ELEVATION
TICK-MARKED ON EDGE OF PAPER
Starting Point
FINISHING POINT
500
500
Ⓐ538
Ⓑ520
620
600
580
560
540
520
500
480
460
440
Sheet of paper

Place sheet of lined paper along profile line and mark points of known elevation .

Any paper with evenly-spaced horizontal lines, such as graph or notebook paper, may be used. The wider the spacing of the lines, the greater the vertical exaggeration in the profile. However, the indication of intervisibility along a line of sight is not affected by the vertical exaggeration in the profile.

PANEL 5-15

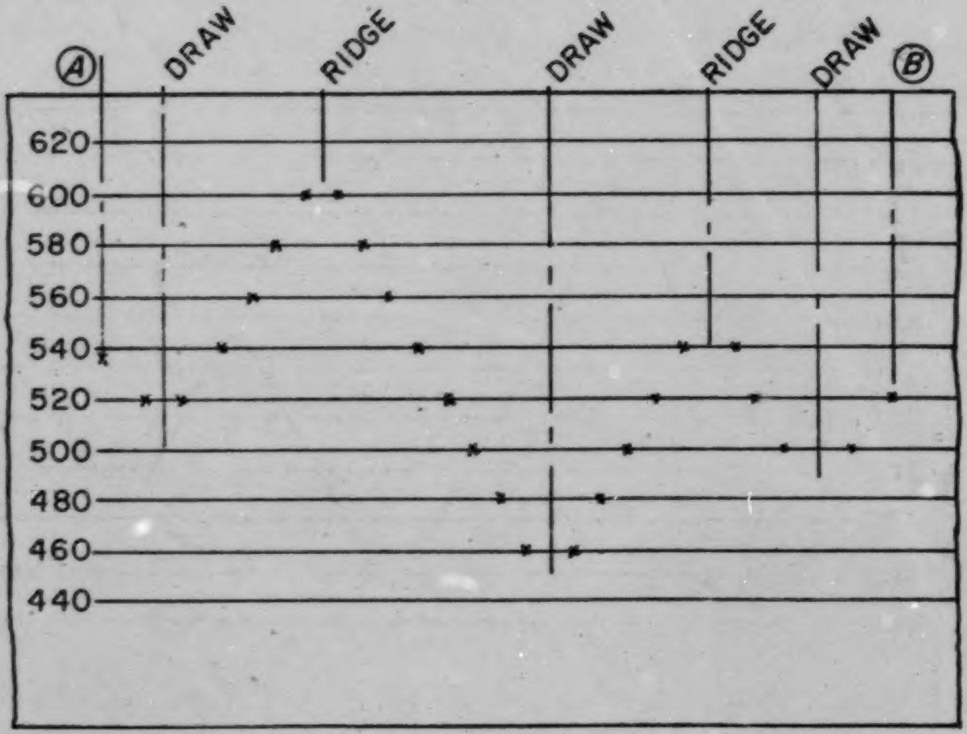
CONSTRUCTING A PROFILE (Continued)


A
B
620
600
580
560
540
520
500
480
460
440

Draw perpendiculars down across horizontal lines for each marked point

PANEL 5-16

CONSTRUCTING A PROFILE (Continued)

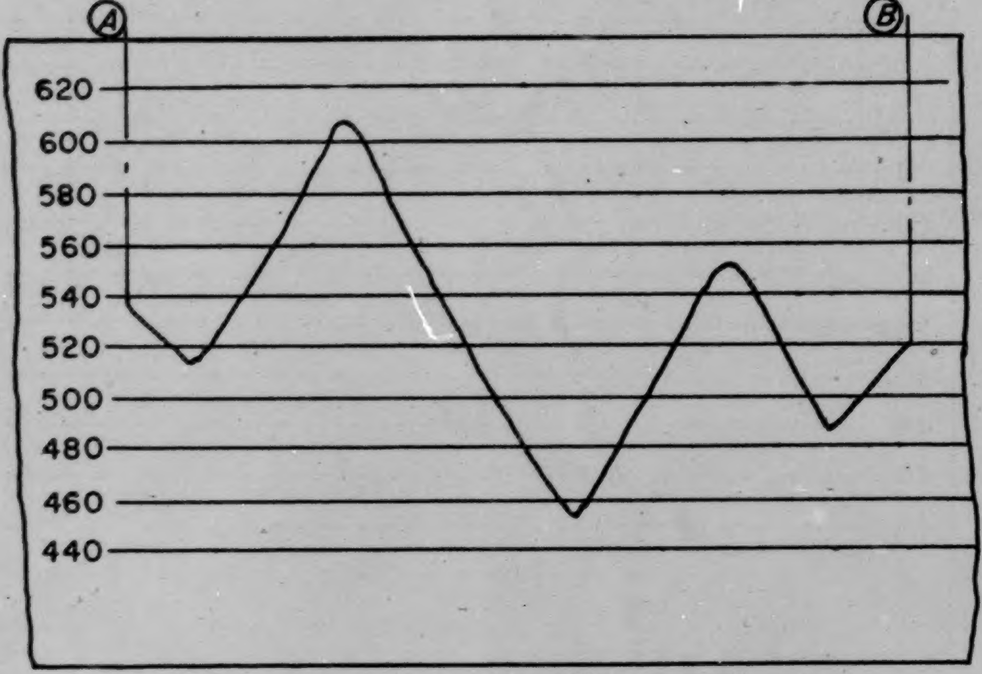


A
DRAW
RIDGE
DRAW
RIDGE
DRAW
B
620
600
580
560
540
520
500
480
460
440

Identify the high and low points along the profile

PANEL 5-17

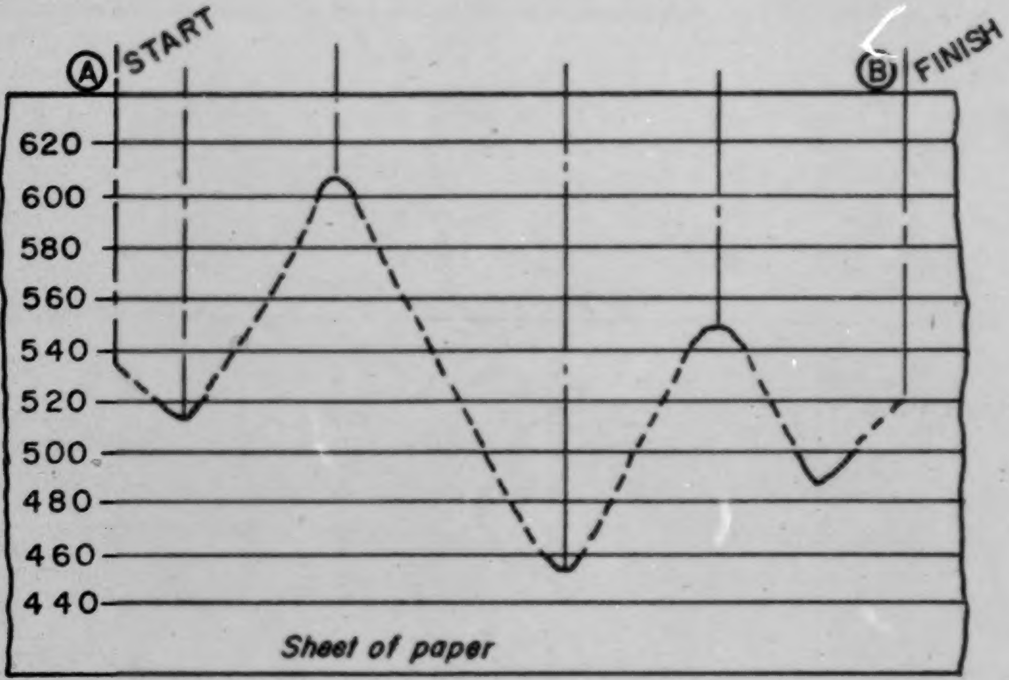
CONSTRUCTING A PROFILE (Continued)



Connect all marked points with a smooth curve

PANEL 5-18

CONSTRUCTING A HASTY PROFILE


Ⓐ START
Ⓑ FINISH
620
600
580
560
540
520
500
480
460
440
Sheet of paper

Plot only the contours identifying the high and low points.

PART VI

MAP SUPPLEMENTS AND SUBSTITUTES

FRAME 1. INFORMATION FRAME.

If no maps are available for an area of operation and there is not enough time to prepare them, map substitutes must be used instead. If there are maps, but they are out-of-date or incomplete, map supplements are needed to give more or newer information. Map supplements and substitutes may be single photographs, photomosaics, photomaps, pictomaps, overlays, or special military sketch maps. The following frames discuss the different kinds of map supplements and substitutes.

(orient) (31)

FRAME 32.

As you learned in Part IV, there are three kinds of north on a map: true, grid, and magnetic. Any of these norths can be transferred from map to photo, but magnetic north is the most commonly used direction on photos. The north line usually plotted on a photo shows the direction of ________________ north.

(hangar) (62)

FRAME 63.

Some or all of the five recognition factors may be used to identify objects on a photograph. For example, you look at a small (size), round (shape), gray (tone), object that looks like a farm silo, a haystack, or a water tank. You still have two of the five factors to consider, ____________, and ____________ ____________ ____________ ____________ ____________.

(photographic) (93)

FRAME 94.

Refer again to the Fort Belvoir pictomap, grid squares 1285 and 1385. Notice that large important buildings are shown by red symbols, drawn the same size and shape as the actual photo image. Many smaller buildings which are either isolated or not part of a regular pattern are also shown in red because their photo images might not show up through the colors of the pictomap. Thus, buildings may be shown either by their photo images or by the same symbols used on ________________ ________________.

(Go on to next frame) (1)

Set 6-1. TYPES OF PHOTOGRAPHS

FRAME 2.

An aerial photograph is taken by a camera mounted in an aircraft flying above the earth's surface. Thus, a photograph taken from an aircraft is called an ________________ photograph.

(magnetic) (32)

FRAME 33.

To plot the magnetic north prong on the photo, it must first be constructed on the map. Draw an angle from a north-south grid line, the **value** of the G-M angle given in the declination diagram in the lower margin of the map. Be sure to use the **value** of the angle, rather than the plotted diagram, which may be exaggerated for clarity. The G-M angle is plotted from a ________________-________________ grid line on the map.

(shadow, relation to other nearby features) (63)

FRAME 64.

Consider the **relation** of the small, round, grayish object **to other nearby features.** Near a group of farm buildings, it might be a silo or a haystack; near a railroad track, it might be a water tank. This leaves one more factor, ____________ ______________________, to consider.

(topographic maps) (94)

FRAME 95.

As you have already learned, contours are shown in black on a pictomap, instead of the brown used on conventional maps. But they are read and interpreted in the same way on a pictomap as on a topographic map. Refer to grid square 1282. The contours along the shoreline are close together. Would you describe this slope as steep or gentle?

(aerial) (2)

FRAME 3.

A photograph can be taken, processed, and distributed in hours while a topographic map takes much longer to produce. What is one advantage of the aerial photograph over a topographic map?

a. quicker to produce

b. larger

c. shows contours better

(north-south) (33)

FRAME 34.

With the photo image correctly alined with the map features, draw a line on the photo parallel to the direction of magnetic north on the map. Label this line with the half-arrow used for magnetic north. This line is used to indicate the ______________________ north direction on the photograph.

(shadow) (64)

FRAME 65.

Shadows present a side view of the object. On a vertical aerial photograph, the overhead view of an object is often unfamiliar. The shadow of an object reveals the more familiar outline of its sides, aiding in its recognition. Also, since the taller the object, the longer its shadow, we can establish the relative height of an object, often the only way to distinguish it from another of similar shape. On any aerial photo, the longer the shadow cast, the ________________ the object.

(steep) (95)

FRAME 96.

Pictomaps are usually prepared at a larger scale than standard topographic maps because the photo image shows up better at larger scales. The scale of the **Fort Belvoir and Vicinity** Special Map is ______________________.

(a. quicker to produce) (3)

FRAME 4.

When the camera is pointed straight down (vertically) toward the earth, it takes a **vertical** photograph (Panel 6-1). Tilted at an angle to the vertical, it takes an **oblique** photograph. What determines whether an aerial photograph is vertical or oblique?

a. altitude of the plane
b. size of the camera lens
c. tilt of the camera axis

(magnetic) (34)

FRAME 35.

Once the magnetic north direction line is plotted on the photograph, it can be easily oriented to the ground with the aid of a magnetic compass. Place the line of sight of the compass on the magnetic north line drawn on the photo, and turn photo and compass until the compass north arrow coincides with the north line drawn on the photo. The magnetic north line on the photo is now oriented to the ground ______________ ______________ direction.

(taller) (65)

FRAME 66.

On a photo you note, in the middle of a field near a farm house, a round object which casts a short shadow. You recognize it as a haystack. Close to the farmhouse is another round object which casts a shadow several times as long. This object is ________________ than the haystack. Its ________________ to the farmhouse would indicate that it is a silo.

(1:25,000) (96)

FRAME 97.

Your map scales and protractor can be used with a pictomap just as with a topographic map. When you want to determine the coordinates of a point on the Fort Belvoir pictomap, which of the map scales would you use?

a. $\frac{1}{25,000}$ b. $\frac{1}{50,000}$

(c. tilt of the camera axis) (4)

FRAME 5.

If the camera is tilted enough, the earth's **horizon** will appear in the photograph (Panel 6-2). This is called a **high oblique.** When the camera is not angled enough to show the horizon, the photograph is a **low oblique** (Panel 6-3). On a high oblique photo, the ____________________ shows on the photograph.

(magnetic north) (35)

FRAME 36.

If north on the photo and on the ground agree, ALL _____________ agree.

(taller, relation) (66)

FRAME 67.

Using information from the previous frames, you recognized the silo by its size (small), ______________ (round), tone (gray), ______________ (height), and ______________ to other nearby features.

$\left(\frac{1}{25,000}\right)$ (97)

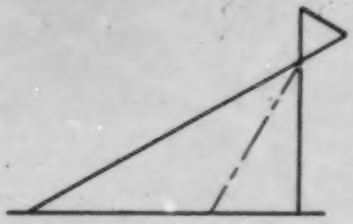
FRAME 98.

A pictomap, like a photomap, has bar scales for distance measurements, grid squares for location of objects, and a declination diagram for the plotting of azimuths. It also has a legend and other marginal data to explain the topographic symbols, just as do ______________________________ maps.

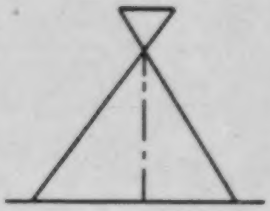
(horizon) (5)

FRAME 6.

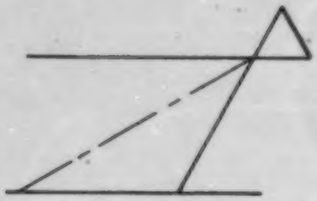
The sketch shows the camera pointed for high oblique, low oblique, and vertical aerial photographs. Which of the following camera positions will produce a vertical photograph?



A



B



C

(directions) (36)

FRAME 37.

With the photograph oriented to the ground, sighting the compass toward any object will result in which reading?

a. magnetic azimuth   b. distance   c. elevation (shape, shadow, relation) (67)

FRAME 68.

As you have seen, tone (or texture) can also aid in identification. Refer to Photo A. The woods in grid square 5047 show a rough or mottled ____________.

(topographic) (98)

FRAME 99. INFORMATION FRAME.

Pictomaps, like photomaps, sometimes contain distortions of the photo image owing to relief. When this is the case, the pictomap should be used only to supplement the information on a topographic map. A note in the margin informs the user of this condition. If the pictomap was prepared from an orthophotomap (see frame 88), the photo detail is as accurately positioned and scaled as on a topographic map and the note is omitted. Refer to the Fort Belvoir pictomap. Notice the caution note printed in red on the left side of the lower margin. Distances measured on this pictomap should be considered approximate; those along level stretches of ground are more reliable than those in the areas of relief variations. Azimuths are also subject to error because of the possible displacement of the photo image.

(b. distance) (6)

FRAME 7.

When aerial photography is made for reconnaissance or map-making purposes, the aerial camera takes a series of pictures, called a flight, as the aircraft flies along. Each succeeding photograph in a flight overlaps the one before by a planned amount, as shown in Panel 6-4. The series of overlapping aerial photographs taken as the aircraft flies along is called a ____________________________.

(a. magnetic azimuth) (37)

FRAME 38.

To find the magnetic north direction on a photo when a map is not available, at least two objects (for example, a church and a crossroads) which appear on the photo must also be identified on the ground. The magnetic azimuth between these two points on the ground is determined with a compass. The line of direction between the images of these two points on the photograph represents the same magnetic azimuth, and can be used to plot the ____________________________ north line on the photograph.

(tone (texture)) (68)

FRAME 69.

A slow flowing river (also undisturbed lakes or ponds) shows a smooth, even texture or tone. If the water surfaces were roughened (fast flowing river or wind blown pond), the photograph would show a rough ____________________.

Set 6-10. OVERLAYS

(Go on to next frame) (99)

FRAME 100. INFORMATION FRAME.

It is often necessary to indicate the position of units, fortifications, etc., as well as the natural and manmade features shown on a map or photograph. This enables you to "see" these units in their relation to the ground features shown on the map. To accomplish this, an overlay — a translucent (almost clear) or transparent (clear) sheet of paper or plastic — is positioned on the map and the military symbols of units, etc., are drawn on this overlay in their proper positions with reference to the map beneath.

(flight) (7)

FRAME 8. INFORMATION FRAME.

Photo intelligence analysts and map makers use special equipment to study overlapping pairs of photographs. Single photographs, however, are valuable sources of information if you know how to read them. The margins on the photograph contain much information about how, when, and where the photograph was taken. This information is used to locate the photograph with relation to the ground, to determine the scale of the photograph and to aid in the identification of images on the photograph.

(magnetic) (38)

FRAME 39.

To orient a photo in the field when a compass is not available, find at least two distinctive objects on the photo which you can identify on the ground. Rotate the photo until the photo images of the objects are in the same direction and relationship as on the ground. Your photo is now ______________________.

(texture (tone)) (69)

FRAME 70.

Refer to photograph A, furnished with this text. The identification factors will be used to identify the school in the upper left corner of grid square 5151.

1. The object is much larger than a house when compared with the ________________ of the houses in the nearby development.

2. The angular outline or ________________ identifies it as a manmade rather than a natural feature.

3. The ________________ of the object is different from surrounding areas, either natural fields or paved areas.

4. The ________________ cast by the object indicates that it is a sprawling structure, taller than individual houses, but lower than most office or apartment buildings.

5. Its ________________ to the athletic fields which make up most of the surrounding grounds makes its identification as a school most logical.

(Go on to next frame) (100)

FRAME 101.

By means of an overlay, both the symbols for units, fortified positions, etc. and the features on the map can be read at the same time. However, information can be of little value unless the user can refer it to the map for which it was prepared. Therefore, the preparer must identify the ________________ for which the overlay was prepared.

(Go on to next frame) (8)

FRAME 9.

Photographs in each flight are numbered in sequence and the number placed in the margin of the photograph. To identify a particular photograph in a flight, you must locate its exposure number in the ______________________________ of the photograph.

Set 6-5. LOCATING POINTS BY POINT DESIGNATION GRID

(oriented) (39)

FRAME 40. INFORMATION FRAME.

To locate points on a photograph, a **point designation grid** is used, just as the military grid is used to locate points on a map. However, the method of point location is the only similarity between the uses of the two kinds of grids. On a large-scale map, the distance between grid lines represents a specific distance on the ground — 1,000 meters — and the vertical grid lines represent the direction of grid north. But on an aerial photograph, the point designation grid cannot represent a specific ground distance because the scale of each photo varies, whereas the spacing between grid lines remains constant. And since the construction of the point designation grid is based on the format of the photo, it does not represent any particular direction. The point designation grid is used solely to locate points on a photograph.

Set 6-7. PHOTO ORIENTATION FOR STUDY

(1. size, 2. shape, 3. tone, 4. shadow, 5. relation) (70)

FRAME 71. INFORMATION FRAME.

You have learned in previous frames how to orient a photo to a map or to the ground. For example, you learned how to locate magnetic north on the photo as an aid to such orientation. In the next few frames, you will learn how to position a photo with relationship to a source of light, to better study and identify the features on it. This is called "orientation for study."

(map) (101)

FRAME 102.

Overlays can be used as annexes to orders or reports to clarify or augment the written information. Military symbols (units, fortifications, etc.) would be found on the ______________ to further augment and clarify ______________ directives.

(margin) (9)

FRAME 10.

In addition to the photo exposure number, the sortie or mission number is also given in the margin of the photograph. These items identify a particular photograph. To identify a photo you need two numbers, ______________________ and ___________________________.

(Go on to next frame) (40)

FRAME 41.

The point designation grid is added by the **user** to each photograph. Copies of the same photograph may be used by many different people. Therefore, each user must orient and draw the point designation grid in **exactly** the same way. Otherwise, the point location on one copy will not agree with the ______________ ______________ on the other copies.

(Go on to next frame) (71)

FRAME 72.

In orienting the photo for study, first turn so that you **face a source of light,** such as a window or a lamp. Next, turn the photo until the **shadows** of the objects on the photo **point toward you** (Panel 6-13). This creates a natural relation of light, images, and shadows. As long as you keep this relation, the photograph is ________________ for ________________.

(overlay, written) (102)

FRAME 103.

Register marks are traced from the map to aid you in accurately positioning the overlay on your map. Register marks may be grid line intersections, road crossings, fiducial marks (on photographs), or even the corners of a map or photograph. Refer to your overlay. The register marks, labeled 30-60 and 40-70, refer to which points on the LEAVENWORTH map?

a. grid line intersections **b.** fiducial marks **c.** map corners

(exposure, sortie or mission) (10)

FRAME 11.

A complete sequence of marginal information appears on the first and last exposure of each flight. Only selected items are given on the intermediate photographs. Where can you find the complete data if it is not on your photo?

a. The next photograph in the flight.

b. The first or last photograph in the flight.

c. The overlapping photograph in an adjoining flight.

(point location) (41)

FRAME 42.

The point designation grid is drawn by the ______________________ and all point designation grids are drawn in the ___________________ way. In the next few frames you will learn how to draw a point designation grid.

(oriented, study) (72)

FRAME 73.

With the photo oriented for study, an illusion of **relief is created.** The "shapes" (high and low places) are apparent although their amount is not measurable. Orientation for study thus creates the illusion of ____________________.

(a. grid line intersections. The 30-60 and 40-70 are grid line labels.) (103)

FRAME 104.

The user can place the overlay on the map in the same position as when it was made if he uses the register marks. On your LEAVENWORTH overlay (and on most military overlays) the register marks are ____________________.

(b. The first or last photograph in the flight) (11)

FRAME 12.

Panel 6-5 illustrates two methods of showing marginal information on aerial photographs. One system is manually lettered; the other records the data automatically as each picture is taken. The style of automatic recording depends upon the kind of camera used. Regardless of the method used, the same information is given. Study photograph A, furnished with this text. Is the marginal data manually lettered or automatically recorded?

(user, same) (42)

FRAME 43.

Panel 6-7 shows four steps in constructing a point designation grid.

Step 1. Locate the center of the four edges of the photograph. Most photographs have reference marks, called "fiducial marks," which mark the __________ of each edge.

(relief) (73)

FRAME 74.

Refer to the aerial photograph in Panel 6-14. If you look closely at the photo, you can see that the shadows point generally toward the right-hand margin of the photo. To orient the photo for study you must turn it so that the shadows (and right margin) are **(toward) (away from)** you.

(grid line intersections) (104)

FRAME 105.

A minimum of two ______________ ______________ are needed to replace the overlay in its correct position.

Note: All paper is subject to changes in size, shrinking or expanding because of heat and humidity. Different kinds of paper are affected in different ways. For this reason, the register marks on the furnished overlay may not fit exactly on the indicated grid intersections on the map. In such cases, position the overlay to the best average fit.

(manually lettered) (12)

FRAME 13.

Refer again to Panel 6-5 and to the furnished photograph, Photo A. What is the focal length of the camera used to take the photograph?

(center) (43)

FRAME 44.

Step 2. Connect opposite fiducial marks with straight lines. The horizontal and vertical lines will cross at the ____________________ of the photograph.

(toward) (74)

FRAME 75.

Holding the photo (Panel 6-14) in this position, turn to face a source of light. You should be able to "see" some of the hills and valleys or the ______________ on the photo. You see that a gorge or ravine crosses the photo. If you position the photo the **wrong way** (with the shadows pointing away from you) the ravine looks like a winding ______________________. Study other objects (especially manmade ones) carefully to make sure that you have turned the shadows correctly toward you.

(register marks) (105)

FRAME 106.

Refer again to your LEAVENWORTH map overlay. Identification of the overlay is made in a **title box** drawn in an unused area of the overlay. The title box must contain the title of the map for which the ____________________ was prepared.

(6") (13)

FRAME 14.

To read the photograph properly, the photo user needs to know the flight altitude — how high the aircraft was flying when the picture was taken. In the automatically recorded marginal data, a picture of an altimeter is usually recorded on the side of the photograph. On the furnished photo, the altitude is lettered in the margin. How high above sea level was the aircraft flying when this photo was taken?

(center) (44)

FRAME 45.

Step 3. The rest of the grid lines are spaced exactly 4 centimeters (1.575 inches) apart, starting from the center lines in each direction. Each square in all point designation grids measures ____________________ cm on each side.

(relief, ridge) (75)

(Note: This technique is a form of optical illusion and depends on time of day of photography, relief involved, and even the photo processing. If you don't suddenly "see" relief, it may be due to the above causes or it may take awhile to train your eyes to see it.)

FRAME 76.

There are no contour lines or elevations on an aerial photograph. Even the orientation for study gives only a "picture" view of relief. Therefore, which measurement **cannot** be made on an aerial photograph?

a. distance b. direction c. elevation

(overlay) (106)

FRAME 107.

The title identifies the map and the objective describes what the overlay is trying to show. Refer to the overlay; the objective of the overlay is ____________ ____________________.

(7000 feet above sea level) (14)

FRAME 15.

Distance measurements on a vertical aerial photograph depend upon the scale (RF) of the photograph just as do distances on a map.

$$\text{Photo RF} = \frac{\text{photo distance}}{\text{ground distance}} = \frac{\text{PD}}{\text{GD}} \quad \text{(Panel 6-6)}$$

The RF of the photograph is the ratio (or fraction) of ________________ distance to ground distance.

---

(4) (45)

FRAME 46.

Step 4. To number grid lines, you must first turn the photo until the exposure number and any manually lettered marginal information is in the normal reading position. On most photographs, this would place the exposure number in the upper left corner. Any time you use a point designation grid, you must place the marginal information in the ________________ ________________ position.

(c. elevation) (76)

FRAME 77.

Two or more adjoining and overlapping aerial photographs can be "joined" by matching the same images in the overlap area. The resulting larger "photograph" is called a **mosaic.** The ____________________ can be extended to cover a large area by adding more overlapping (and sidelapping) photos. (Panel 6-15)

(situation report) (107

FRAME 108.

Since military situations can change rapidly, the time and date of the information are also included in the ____________________ ____________________.

(photo) (15)

FRAME 16. INFORMATION FRAME.

Ground distance on the photo may be determined in one of three ways: by actually measuring the distance on the ground between two points that appear on the photo; by identifying and measuring on the photo the image of some feature or object whose actual dimensions are known; or by relating the measurement between two points on a photograph to the measurement between the same two points on a map of known scale.

(normal reading) (46)

FRAME 47.

Refer to Panel 6-7. The center lines, both vertical and horizontal, are numbered 50. The numbers of the vertical lines increase (read) to the __________. Numbers along the horizontal lines increase up. The numbers desgnating the ______________________ lines of the photo will always be as shown in the margin.

(mosaic) (77)

FRAME 78.

Adding a standard military grid, marginal information, and names to a mosaic, and printing it at a definite map scale produces a **photomap** (Panel 6-16). A ____________________ contains many features similar to a topographic map and is quicker to produce.

(title box) (108)

FRAME 109.

To prove that the overlay is authentic, the name, rank and organization of the author must be included. The author's signature fixes ____________________ for the data on the overlay.

(Go on to next frame) (16)

FRAME 17.

In computing photo RF, both ground distance and photo distance must be expressed in the same unit. If inches are used in the numerator (photo distance), inches must also be used in the denominator (ground distance). If the distance between two points on a photograph is measured as one inch, and on the ground the same distance is measured as one mile (63,360 inches), what is the RF of the photo?

a. $\frac{1}{12}$ b. $\frac{1}{5,280}$ c. $\frac{1}{63,360}$

(right, grid) (47)

FRAME 48.

Again look at step 4 of Panel 6-7. The grid lines are numbered to read right and up (just as on a map). Grid square 5252 will always be located in which quarter of the photo?

a. upper left b. upper right c. lower right

(photomap) (78)

FRAME 79.

A photomap is a mosaic (many overlapping photographs) which is printed in a map size and shape. The features on a ______________ are not symbols, but photographic images.

(responsibility) (109)

FRAME 110.

The title box on the overlay furnished with this text identifies the following:

1. ______________ (title)
2. ______________ (objective)
3. ______________ (data of overlay)
4. ______________ (rank of author)

(c. $\frac{1}{63,360}$) (17)

FRAME 18.

When the scale of the photo is large, it is often possible to identify and measure features that have standard known dimensions, such as athletic fields, large aircraft with known wing spans, or naval vessels of known length. For example, the 10-yard lines on a football field are usually clearly marked, and can be identified on a large-scale photograph. The length of the field is standard — 300 feet, or 360 feet if the end zones are included. The RF is computed by converting the known length of the football field (GD) to the same unit of measurement used on the photo (PD). Features of known dimension can be used in the formula $\frac{PD}{GD} = RF$ because their ________________ distance is known.

(b. upper right) (48)

FRAME 49.

Points are located on the point designation grid using 6-digit coordinates (as on a map). A _____-digit reading to the right is combined with a _____-digit reading up.

(photomap) (79)

FRAME 80.

Refer again to the photomap on the reverse side of the LEAVENWORTH map. Which of the following information on a topographic map is not shown on the photomap?

a. grids   b. declination diagram   c. legend

1. Leavenworth 1:50,000 map (sheet 7062 IV)
2. SIT REP
3. 9 Sept 65
4. 2d Lieutenant (110)

FRAME 111.

Information drawn on the overlay need not duplicate the topographic symbols unless the overlay shows a change in a topographic feature on the map. The symbols on the enclosed overlay are ____________________ symbols and do not duplicate the map information.

(ground) (18)

FRAME 19.

If you identify a football field on a photograph, and measure its length (without the end zones) as .36 inch, what is the scale of the photo?

a. $\frac{1}{3600}$ b. $\frac{1}{7200}$ c. $\frac{1}{10,000}$

(3, 3) (49)

FRAME 50.

The first 2 digits (both right and up) are the two figures with which the lines are numbered and represent the lower left-hand corner of the grid square. The third digit (in each instance) is the distance measured within the grid square. Thus, a point located in the exact center of grid square 4949 has 6-digit coordinates of ____________________.

(c. legend. Images on the photomap are photographic and a symbol legend is not needed) (80)

FRAME 81.

The photomap is an excellent map substitute within its limits. It has a scale for distance measurements, and grid lines for location and direction measurements. Which measurement cannot be made on a photomap?

a. distance b. direction c. relief

(military) (111)

FRAME 112.

Other useful information, such as scale and north arrow on a photograph, are added where necessary. North arrows are **not** needed on **map** overlays because the vertical grid lines identify grid ____________________.

(c. $\frac{1}{10,000}$. 300 ft. × 12 = 3600 in.

$\frac{PD}{GD} = \frac{.36}{3600} = \frac{1}{10,000}$) (19)

FRAME 20.

When a map of the same area is available, the ground distance (GD) between two points can be obtained by multiplying the measured map distance (MD) by the denominator of the map RF. For example, 1 inch on a map having an RF of $\frac{1}{50,000}$ equals 50,000 inches of ground distance. This can then be used with the measured photo distance between the same two points in the formula $\frac{PD}{GD}$ = RF of photo.

You can use a map of the same area to determine the scale of a photo because you can determine the ____________________ ____________________ from the map.

(495495) (50)

FRAME 51. INFORMATION FRAME.

Because the same point designation grid numbers are used on all photomaps, the coordinates of a point on the photograph must be preceded by the mission and exposure numbers to identify the photograph when reporting a photo point location. The grid reference consists of three parts:

1. The letters "PDG" to indicate aerial photo coordinates rather than map grid coordinates.
2. The mission and exposure numbers of the photograph.
3. The six digits which actually locate the point on a photograph.

(c. relief) (81)

FRAME 82.

Refer to the LEAVENWORTH photomap. The grid on it is a standard military grid. As you learned concerning the grid on the LEAVENWORTH topographic map, the length of each side of the grid square is ________ meters.

(north) (112)

FRAME 113.

Detailed route information is given on the route reconnaissance overlay illustrated in Panel 6-17. Special route reconnaissance symbols (identified in FM 5-36) indicate critical widths and clearances, curves, and gradients. The road slope north of the river is shown by methods described in Part V, frame 43. What is the slope?

a. 1/10

b. 8 percent

c. 6 degrees

(ground distance) (20)

FRAME 21.

When you have a map of the same area, you can combine the steps of finding the ground distance, and then the photo scale, by using the formula

$$\frac{PD}{MD} \times \text{Map RF} = \text{Photo RF}$$

Example: The photo distance between two points is 10 centimeters. On a 1:50,000 scale map, the map distance between the same two points is 5 centimeters. Substituting in the formula: Photo RF $= \frac{10}{5} \times \frac{1}{50{,}000}$, what is the RF of the photo?

a. $\frac{1}{25{,}000}$ b. $\frac{1}{50{,}000}$ c. $\frac{1}{100{,}000}$

(Go on to next frame.) (51)

FRAME 52.

Refer to photograph A supplied with this text. The exposure number is 565. What is the mission number?

a. M-109 b. 0730 Z c. VV702

(1000) (82)

FRAME 83.

A standard military grid on the photomap permits reading 6-digit grid coordinates. Locate RJ 997 (road junction, elevation 997) in grid square 4664. What are the 6-digit coordinates for this point?

a. 460640 b. 462644 c. 468646

(b. 8 percent) (113)

FRAME 114.

The ____________________ ____________________ in the lower right corner must be filled out with pertinent information to identify the overlay.

$(\frac{1}{25{,}000})$ (21)

FRAME 22.

The photo RF ratio, $\frac{\text{photo distance}}{\text{ground distance}}$, is in the same proportion as $\frac{\text{focal length of lens}}{\text{height of camera}}$ (see Panel 6-6) $\frac{\text{photo distance}}{\text{ground distance}} = \frac{\text{focal length of lens}}{\text{height of camera}}$ What is the focal length given on the photo furnished with this text?

a. 702 b. 6 in. c. 7000′

(a. M-109) (52)

FRAME 53.

The sides of the 4-cm grid squares of the point designation grid (PDG) are exactly the same size as the RF 1:25,000 map scale shown on your protractor. This scale can be used to find the 3d and 6th digits of PDG coordinates. Using this scale, which of the following locates a baseball diamond on Photo A?

a. PDG M-109 565 508509

b. PDG M-109 565 494483

c. PDG M-109 565 486507

(c. 468646) (83)

FRAME 84.

The road leading south from RF 997 is pointed directly at Platte City. The grid azimuth of the road is 181½ degrees. What magnetic azimuth (see frame 4-84, Part 4) would describe this direction to Platte City?

a. 172 b. 181½ c. 191

(title box) (114)

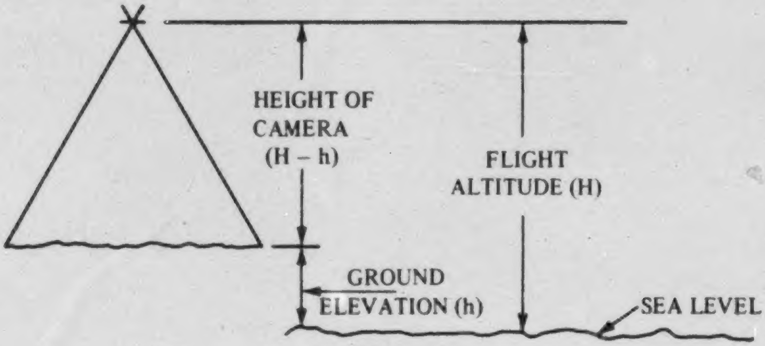
FRAME 115.

The register marks on the route reconnaissance overlay indicate that it is referred to a map, because the register marks are ____________________ ____________________ intersections.

(6 in.) (22)

FRAME 23.

The flight altitude, given on the photograph, is measured from mean sea level (see sketch). The average ground elevation above mean sea level must also be determined and subtracted from the flight altitude to find the height of the camera above the ground. To determine "height of camera" you must subtract ____________________ ____________________ from the flight altitude.



(a. PDG M-109 565 508509) (53)

FRAME 54.

To review, the lines on a point designation grid cannot be used to find either distance or direction on the ground. They can be used ONLY for which of the following?

a. determining direction b. locating points c. measuring distances

(a. 172. You must subtract the GM angle (grid to magnetic)). (See instructions in declination diagram on Leavenworth photomap.) (84)

FRAME 85.

Refer to grid square 4764, just east of RJ 997. The topographic map shows mostly relief information and some woods in this square. On the photomap, you see fence lines, woods outlines, and even individual trees. For example, on the **topographic map,** 476646 refers to a point on the contour marking the hilltop. What is the description of this same location on the photomap?

a. woods patch b. fence corner c. road junction

Set 6-11. MILITARY SKETCH MAPS

(grid line) (115)

FRAME 116.

A military sketch is a drawing on a sheet of opaque (not transparent) paper. It usually substitutes for, rather than supplements, a map. A ________________ is drawn to satisfy a tactical or administrative requirement.

(ground elevation) (23)

FRAME 24.

The RF ratio can now be expressed as:

Photo RF = $\frac{fl}{H-h}$, where fl = focal length
H = flight altitude
h = ground elevation

Which of these three values is not given in the marginal information?

a. fl   b. H   c. h

Set 6-6. IDENTIFYING OBJECTS ON PHOTO

(b. locating points) (54)

FRAME 55.

The legend on the LEAVENWORTH map helped you identify (recognize) streams, roads, hills and other features. You have to identify objects on a photograph without help from a __________________.

(b. fence corner) (85)

FRAME 86.

A photomap furnishes a great amount of detail which is not shown on the topographic map. This is due to the photomap's ________________ images.

(sketch) (116)

FRAME 117.

Sketches vary from freehand drawings to carefully diagrammed ones. Since a sketch may not be referred to a map, its identification (title, objective, date and author) in its ____________ ____________ must be complete.

(c. h. The ground elevation is not given on the photo. Altitude and focal length of camera are.) (24)

FRAME 25.

$$\text{Photo RF} = \frac{\text{fl}}{\text{H-h}}$$

To obtain average ground elevation (h), you can use a topographic map of the same area as your photo. If a map is not available, you obtain the average ground elevation from reconnaissance reports and other intelligence sources. If you have a map, plot the area covered by your photo on the map, and determine the high and low elevations from the contours. To obtain average ground elevation from a map, you must check the ____________________ in the area covered by the photo.

(legend) (55)

FRAME 56.

The colors on a topographic map help you identify streams and swamps, orchards and woods, and built-up areas. You have to identify objects on aerial photographs without the assistance of ____________________.

(photographic) (86)

FRAME 87.

Photomaps are usually used as map supplements. Because photomaps are made from aerial photographs, they sometimes contain distortions. If the photos are slightly tilted, or the terrain very rugged, the photo images of features are displaced, and measurements of distance and direction are not reliable. Such photomaps are usually used with topographic maps to provide new or additional information. They are used as map ________________.

(title box) (117)

FRAME 118.

Panel 6-18 illustrates a strip map, a type of sketch, to be used by a vehicle convoy. The information shows routes to follow, general directions, distances, and checkpoints. Refer to the strip map. What types of topographic symbols are added as check points?

a. road surface classification

b. stream, road and railroad crossings

c. elevations

(contours) (25)

FRAME 26.

Refer to photograph A furnished with this text. By studying the contours and spot elevations on a large-scale map of Northern Virginia, you determine that the average ground elevation in the area covered by the photograph is 250 feet. Using this information and the flight altitude given in the margin of the photograph, what do you determine the scale of the photograph to be?

a. $\frac{1}{6750}$ b. $\frac{1}{13,500}$ c. $\frac{1}{14,000}$

(color) (56)

FRAME 57.

There are five factors which help you identify objects on an aerial photo:

1. size
2. shape or pattern
3. shadow
4. tone or texture
5. relation to other nearby features

In reading photographs, we use the recognition factors size, shape or pattern, ____________________, tone or texture, and ________________ ________________ ________________ ________________.

(supplements) (87)

FRAME 88.

An **orthophotomap** is a special type of photomap which may be used in place of a topographic map. The photographs are printed with equipment that eliminates the scale and image distortions resulting from tilted photographs and from rugged relief. These are called **orthophotographs.** An orthophotomap, made from orthophotographs, is just as accurate as a topographic map. It may be used as a map ________________.

(stream, road and railroad crossings) (118)

FRAME 119.

Another type of sketch (Panel 6-19) is more detailed than the strip map. The author has added his field notes and computations to the sketch. He started at an elevation of 34 meters. What is his finishing elevation?

a. 20.9 b. 72.2 c. 121.5

(b. $\frac{1}{13{,}500}$. $RF = \frac{fl}{H\text{-}h} = \frac{6''}{7000' - 250'} = \frac{.5'}{6750} = \frac{1}{13{,}500}$) (26)

FRAME 27.

The photo scale for the areas of higher elevations is different from the scale for the lower areas of the same photograph. Therefore, photo scale is usually considered approximate unless the terrain is very level, or if special printing methods have been used. Differences in elevation may cause differences in __________________ within a single photograph.

(shadow, relation to other features) (57)

FRAME 58.

Size is a factor in identifying objects. In looking at the aerial photo of a portion of Fort Belvoir (Panel 6-8) you see buildings of various sizes. The large buildings include those containing offices, classroom buildings of the Engineer School, and barracks. You would assume that the small buildings on the semicircular road at the top left of the photo might be family __________________.

Set 6-9. PICTOMAPS

(substitute) (88)

FRAME 89.

Pictomaps are a type of map product that is also made from photomosaics. However, the gray tones of the photo image are printed in natural colors on the pictomap. Some topographic map information is also overprinted in color on the photo image. The special map, FORT BELVOIR AND VICINITY, furnished with this text, is a pictomap.* A pictomap combines the features of a photomap printed in ______________ ______________ with many of the symbols of a ______________ ______________.

---

*See **Note** in materials list in front of this text.

(b. 72.2) (119)

FRAME 120.

The distances on the sketch were measured in strides, but the bar scale at the bottom of the sketch indicates that the distances were plotted in __________.

(scale) (27)

FRAME 28.

When the difference between the high and low elevations in a single photograph is very great, it is better to compute two separate scales than to use an average elevation. On most photographs, however, it is sufficient to use the ____________________ ____________________ to compute scale.

(quarters or housing) (58)

FRAME 59.

The shape of objects is used to identify them. Natural objects are usually irregular in shape. Look at Panel 6-9. You see that the manmade objects are ____________________ in shape and contain ____________________ lines.

(natural colors, topographic map) (89)

FRAME 90.

The pictomap's basic tone (tan color or "landtone") shows bare ground. Vegetation is shown in green ("vegetone"). The darker shades and shadows are emphasized by a black-green color ("shadowtone"). You would identify bare ground by ________________ color and vegetation by ________________ color.

(meters) (120)

FRAME 121.

Sketches may be drawn to cover areas as well as single routes. They may be combined with other area sketches to increase the ________________ that is covered.

(average elevation) (28)

FRAME 29.

If you know the scale of the photo, you can determine ground distance the same way as when using a map. Multiply the photo measurement by the denominator of the photo RF and convert to the desired unit of measurement, if necessary. What is the ground distance in feet between two points which are 2.4 inches apart on a photo whose RF is $\frac{1}{20{,}000}$?

a. 2400 b. 4000 c. 48,000

(regular, straight) (59)

FRAME 60.

Shadows of objects on aerial photos are used to identify them and also to determine their relative heights. Panel 6-10 is an aerial view of a prison. Notice that the water tower is easily identified by its shadow. The shadow of the water tower (upper left in photo) is ____________ than the shadow of the guard tower in the corner of the prison wall (below and to the left of the water tower). You know from this that the water tower is ____________ than the guard tower.

(tan, green) (90)

FRAME 91.

The darker shades and shadows are emphasized in ____________________.

(area) (121)

FRAME 122.

Outpost sketches are made of the terrain ahead of an outpost line. The sketcher must rely on his sketching ability. If the sketcher makes his sketch from an OP, he is making a place sketch which is a form of ____________________ sketch.

Set 6-4. FINDING DIRECTION ON A PHOTO

(b. 4000) (29)

FRAME 30. INFORMATION FRAME.

Directions on an aerial photograph are not shown as on a map. There are no military grid lines, nor are parallels and meridians shown. If a north direction is needed, it must be determined and plotted by the user. The exposure number and any manually lettered marginal data are usually shown along the leading edge of each photo — that is, the front edge as the aircraft was traveling. This edge is frequently referred to as the "top" of the photo, although it can be **any compass direction,** depending on the direction of flight.

(longer, higher (taller)) (60)

FRAME 61.

Tone and texture of objects shown in an aerial photo (Panel 6-11) provide clues to their identification. Woods and forests, for example, show a rough texture. Quiet ponds and lakes show a smooth tone or texture. The smooth tone or texture of the triangular shaped object below and to the right of the top center of the photo indicate it is a ____________________ or ____________________. The rough texture shown in most of the center and lower right areas of the photo indicate ____________________ or ____________________. (This photo was taken after a light snowfall.)

(black-green) (91)

FRAME 92.

Topographic information is overprinted on the pictomap. Contours and such cultural information as boundaries, railroads, and names are printed in black. Drainage features (swamps, rivers, etc.) are overprinted in blue and important roads and buildings in red. On a **topographic** map, as you have learned previously, the contours are printed in brown. In a **pictomap,** you would find contours printed in ________________.

(outpost) (122)

FRAME 123.

Information on sketches is useless unless the user can identify the location of the sketch. The location is noted in the ________________ ________________.

(Go on to next frame) (30)

FRAME 31.

If a map is available, the photograph is oriented to the map, i.e., **turned until the photo images of the ground features** (roads, etc.) **are in the same relation** (directions as you look at them) as **their** equivalent map features. North on the photo will then coincide with (or be parallel to) north on the map. To find north, you ____________________ the photo to the map.

Turn back to bottom of page 6-1 for frame 32

(pond or lake, woods or forests) (61)

FRAME 62.

The relation of an object to other nearby features on the photo can also help you to identify the object. In Panel 6-12, the building with the checkered roof close to the airplane parking apron of the airfield would be a ________________.

Turn back to top of page 6-2 for frame 63

(black) (92)

FRAME 93.

Refer to the special map, FORT BELVOIR AND VICINITY, furnished with this text. This is a pictomap. Notice that there is both photographic detail and topographic information. For example, in the housing development in grid square 1490, the exact street pattern and the individual homes are distinctly shown. This is a ________________ image of the housing development.

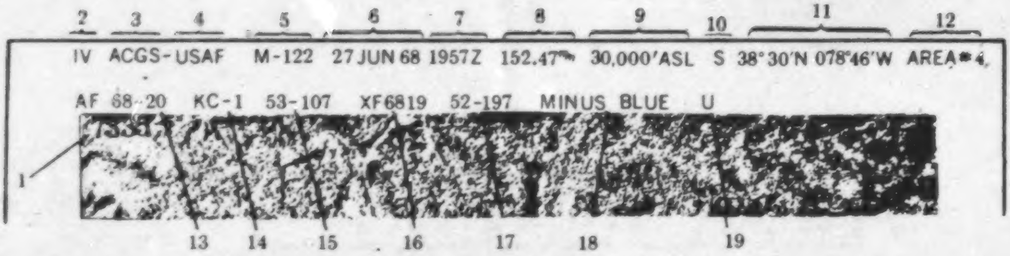
Turn back to bottom of page 6-2 for frame 94

(title box) (123)

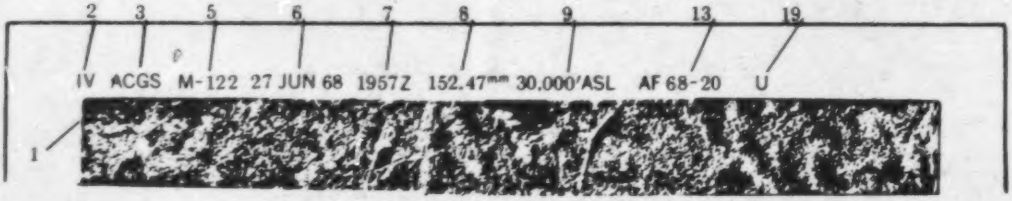
END OF FRAMES FOR PART VI

PANEL 6-5 — MARGINAL INFORMATION

a. DATA RECORDED MANUALLY


2 3 4 5 6 7 8 9 10 11 12
IV ACGS-USAF M-122 27 JUN 68 1957Z 152.47mm 30,000'ASL S 38°30'N 078°46'W AREA#4
AF 68-20 KC-1 53-107 XF6819 52-197 MINUS BLUE U
1
13 14 15 16 17 18 19

FOR FIRST AND LAST EXPOSURE OF EACH FLIGHT
INCLUDING LAST EXPOSURE OF EACH ROLL


2 3 5 6 7 8 9 13 19
IV ACGS M-122 27 JUN 68 1957Z 152.47mm 30,000'ASL AF 68-20 U
1

FOR INTERMEDIATE EXPOSURES

PANEL 6-5 — MARGINAL INFORMATION (Continued)

b. DATA RECORDED AUTOMATICALLY

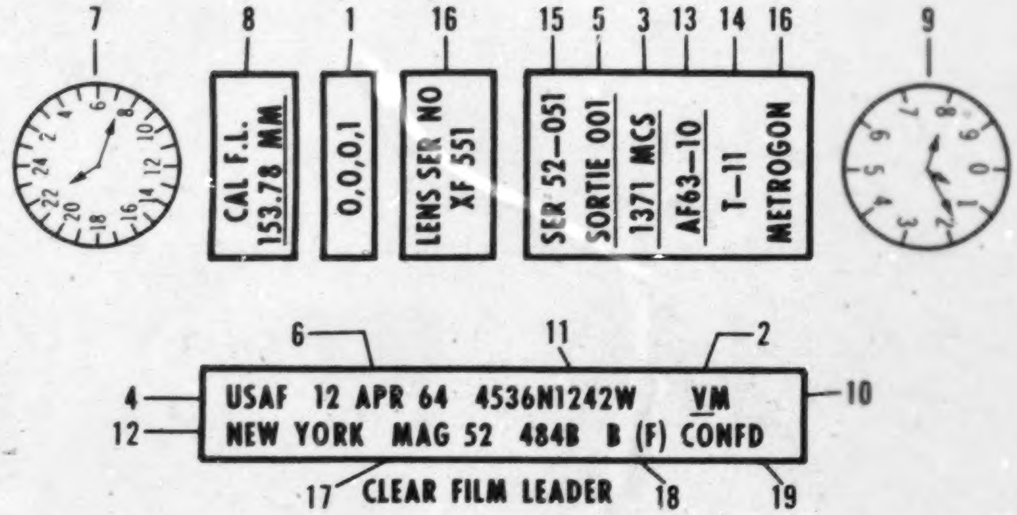

7
8
1
16
15
5
3
13
14
16
9
CAL F.L.
153.78 MM
0,0,0,1
LENS SER NO
XF 551
SER 52—051
SORTIE 001
1371 MCS
AF63—10
T—11
METROGON
6
11
2
4
10
12
USAF 12 APR 64 4536N1242W VM
NEW YORK MAG 52 484B B (F) CONFD
17
CLEAR FILM LEADER
18
19

PHOTO IDENTIFICATION DATA

1. EXPOSURE NUMBER
2. CAMERA POSITION
3. TAKING UNIT
4. SERVICE
5. SORTIE/MISSION NUMBER
6. DATE
7. TIME GROUP AND ZONE LETTER
8. FOCAL LENGTH
9. ALTITUDE
10. KIND OF PHOTOGRAPHY
11. GEOGRAPHIC COORDINATES
12. DESCRIPTIVE TITLE
13. PROJECT NUMBER OR CODE NAME
14. CAMERA TYPE AND SERIAL NUMBER
15. LENS CONE SERIAL NUMBER
16. LENS TYPE AND SERIAL NUMBER
17. MAGAZINE TYPE AND SERIAL NUMBER
18. FILM AND FILTER USED
19. SECURITY CLASSIFICATION

PANEL 6-6 — PHOTO RF

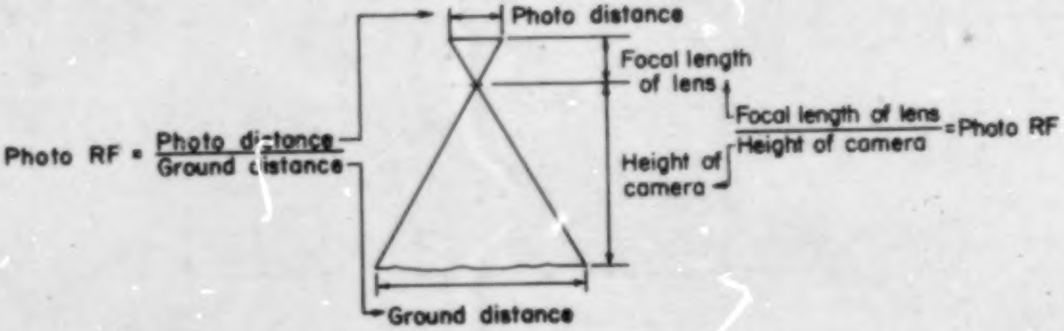
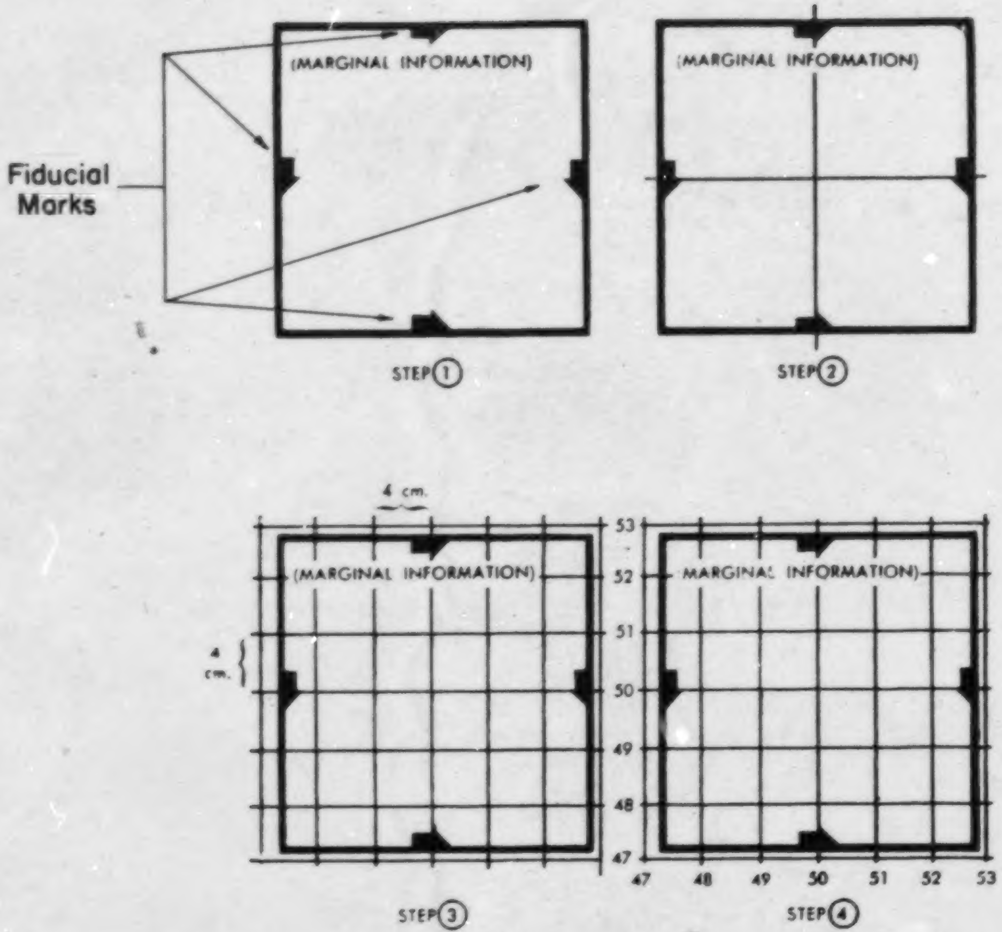


Photo distance
Focal length of lens
Photo RF = Photo distance / Ground distance
Focal length of lens / Height of camera = Photo RF
Height of camera
Ground distance

PANEL 6-7


Fiducial Marks
(MARGINAL INFORMATION)
4 cm.
4 cm.
53
52
51
50
49
48
47
47
48
49
50
51
52
53

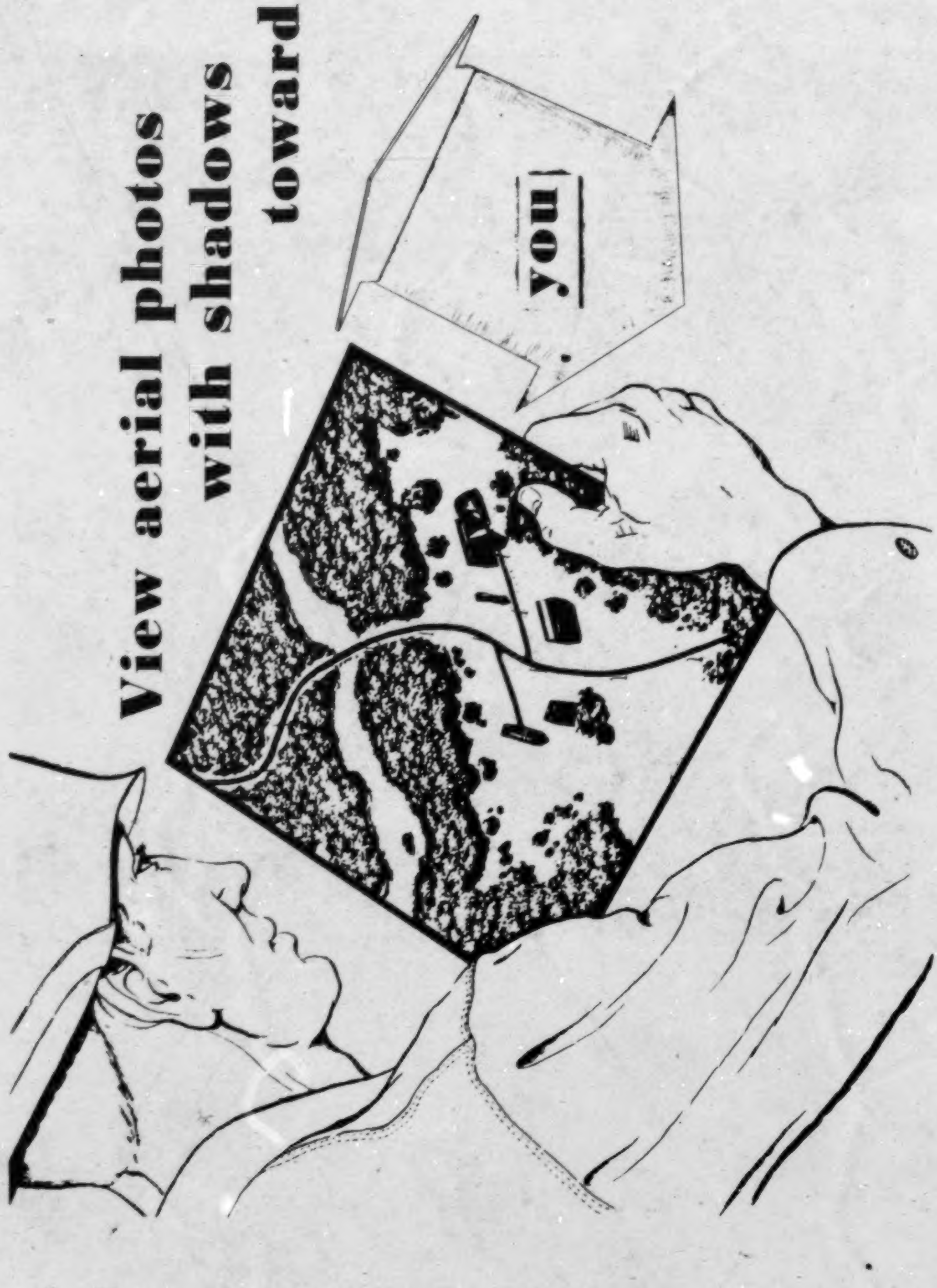
STEP ①

STEP ②

STEP ③

STEP ④

PANEL 6-13


View aerial photos
with shadows
toward
you

PANEL 6-15

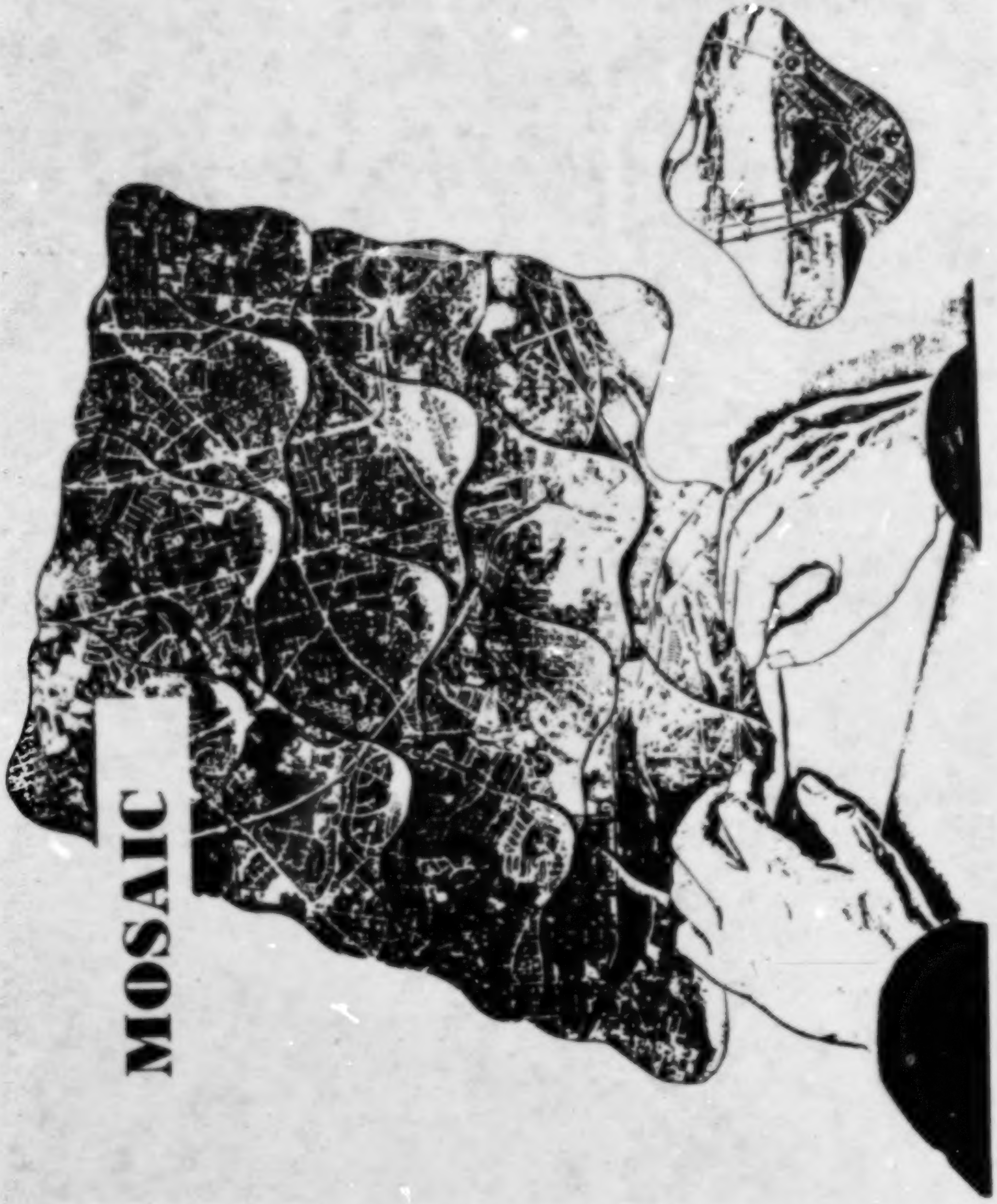
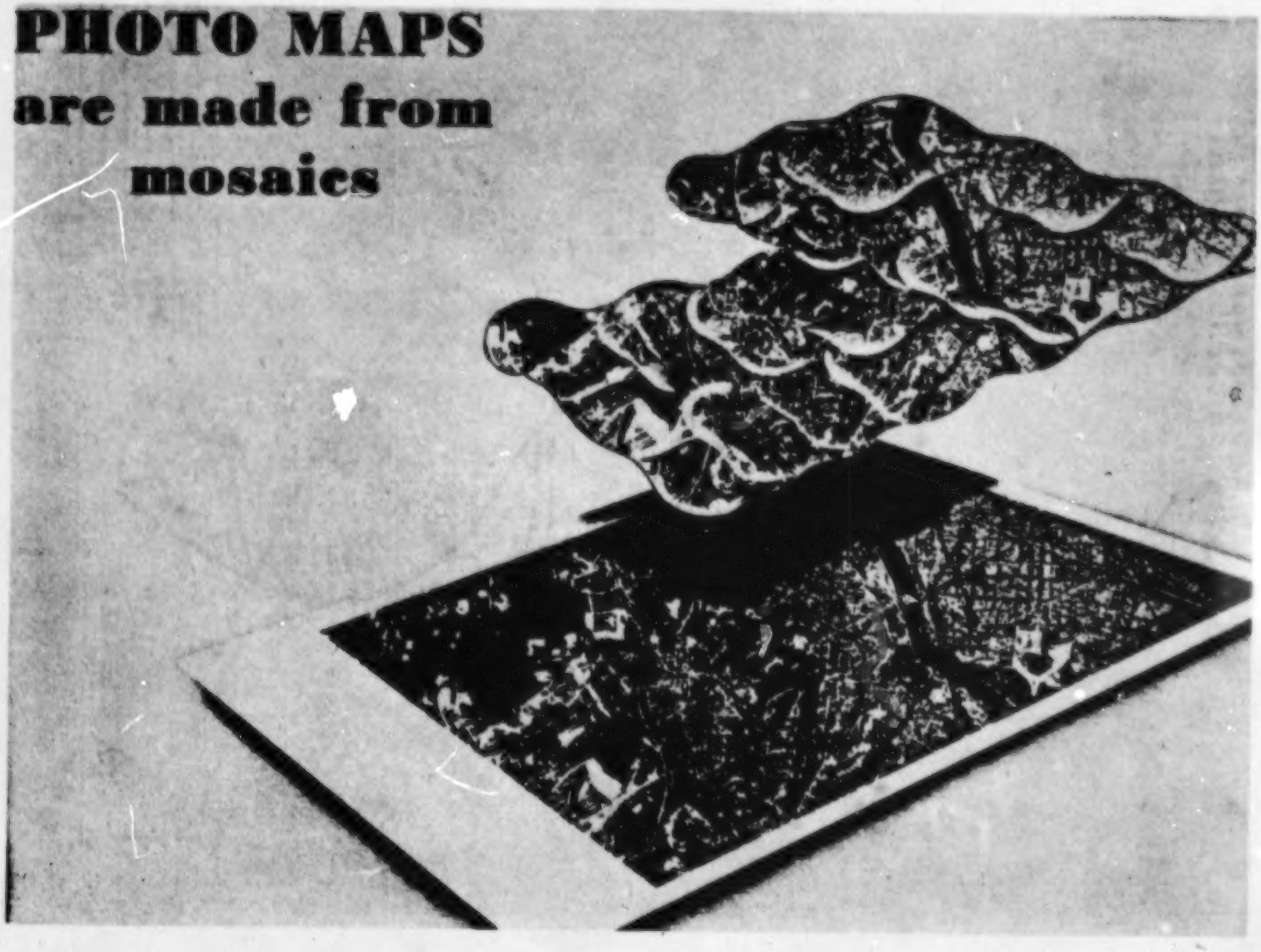
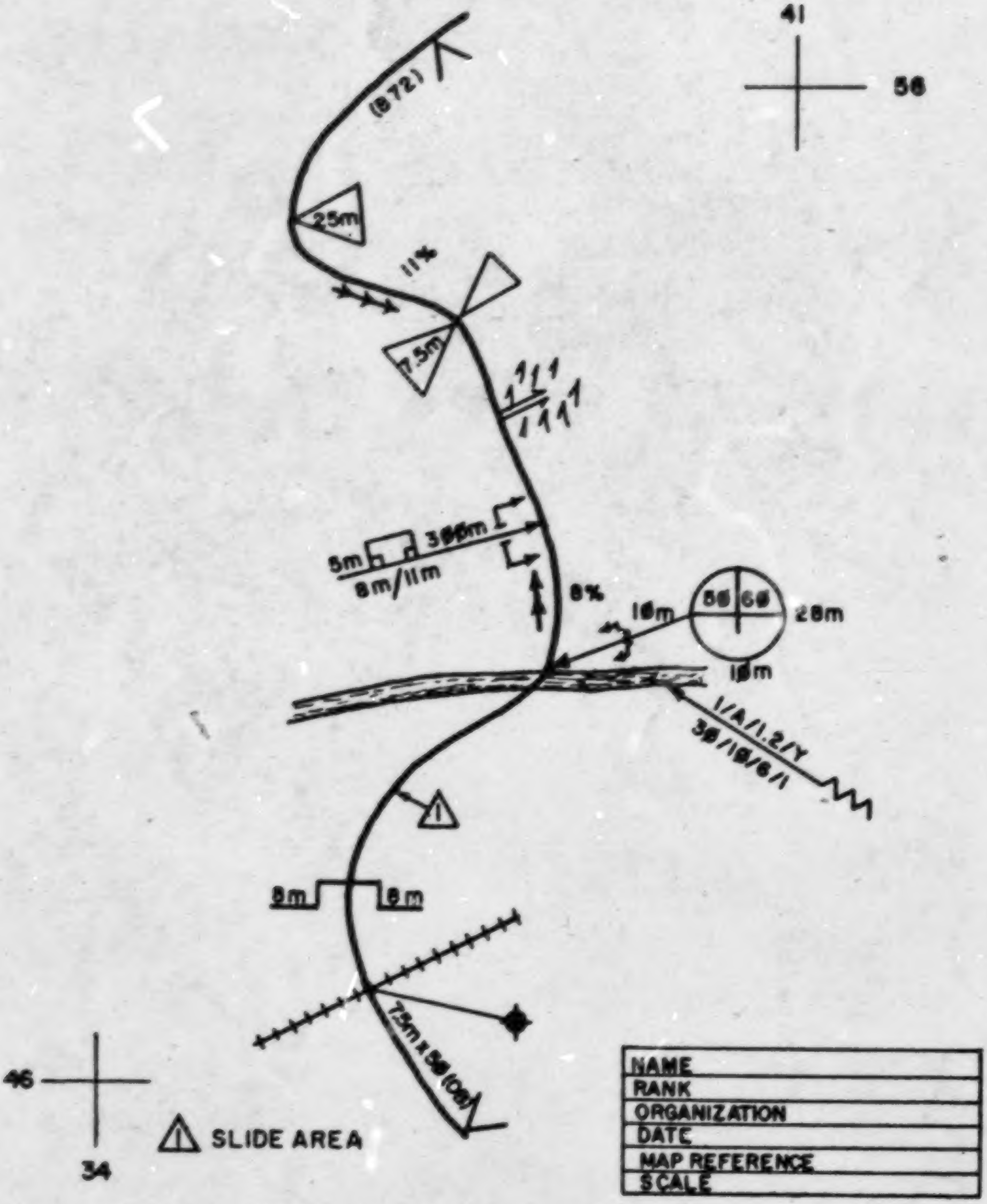


PHOTO MAPS
are made from
mosaics



PANEL 6-17

ROUTE RECONNAISSANCE OVERLAY

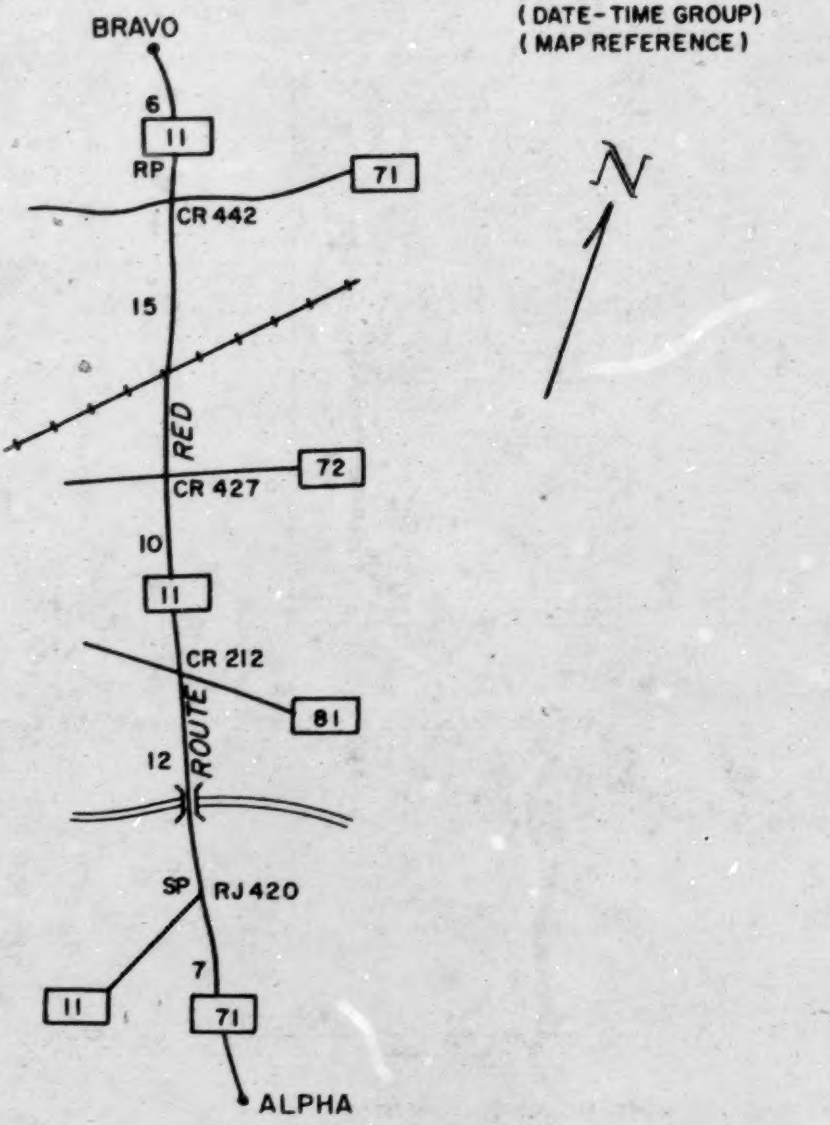

41
56
(872)
25m
11%
7.5m
300m
5m
8m/11m
8%
10m
50
60
20m
10m
1/A/1.2/Y
30/10/6/1
8m
8m
7.5m x 50 (08)
46
34
SLIDE AREA
NAME
RANK
ORGANIZATION
DATE
MAP REFERENCE
SCALE

PANEL 6-18

STRIP MAP

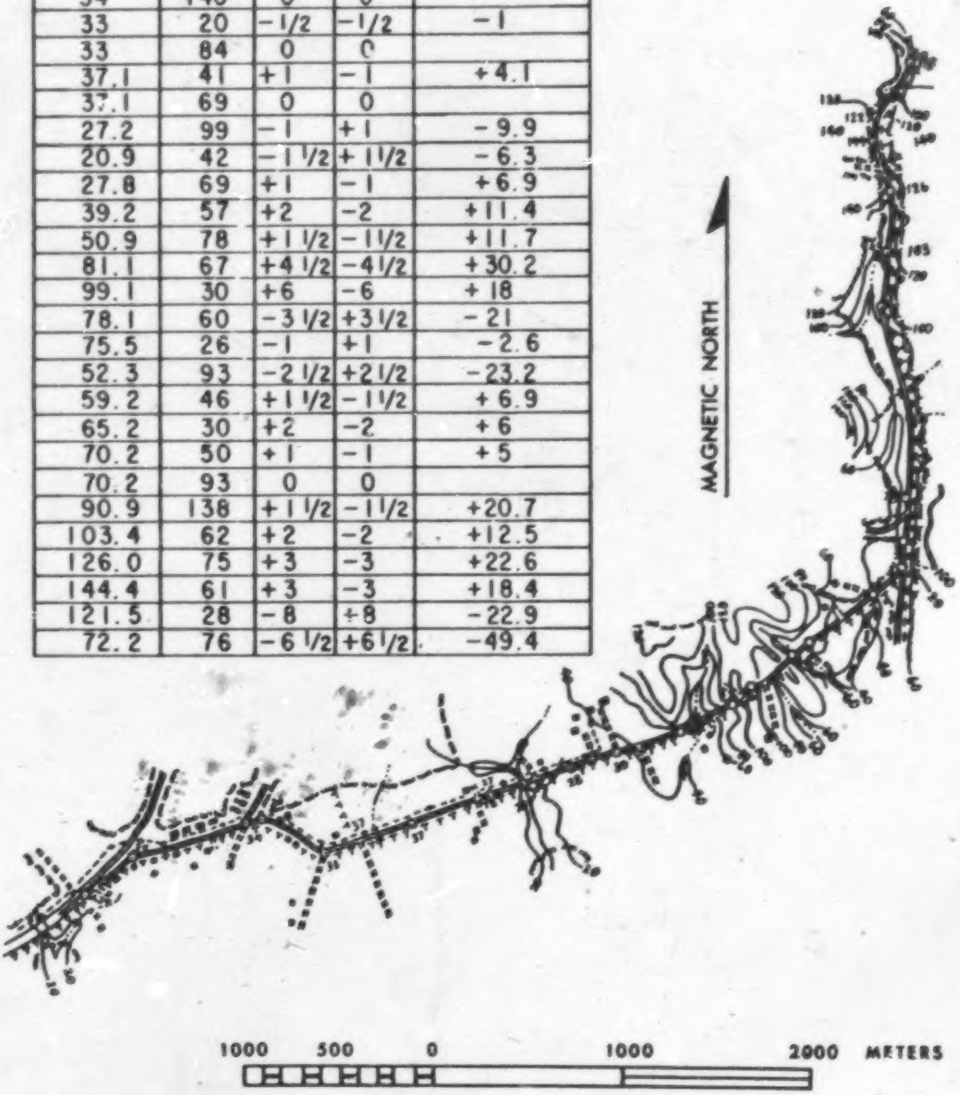
(Classification)

ANNEX ___ TO OPORD ____
(UNIT)
(DATE-TIME GROUP)
(MAP REFERENCE)


BRAVO
6
11
RP
71
CR 442
15
RED
72
CR 427
10
11
CR 212
ROUTE
81
12
SP
RJ 420
7
11
71
ALPHA
N

PANEL 6-19

ELEVATION	PACES	CLINOMETER		DIFFERENCE OF ELEVATION
		FORE	BACK	
34				
34	72	0	0	
34	140	0	0	
33	20	−1/2	−1/2	−1
33	84	0	0	
37.1	41	+1	−1	+4.1
37.1	69	0	0	
27.2	99	−1	+1	−9.9
20.9	42	−1 1/2	+1 1/2	−6.3
27.8	69	+1	−1	+6.9
39.2	57	+2	−2	+11.4
50.9	78	+1 1/2	−1 1/2	+11.7
81.1	67	+4 1/2	−4 1/2	+30.2
99.1	30	+6	−6	+18
78.1	60	−3 1/2	+3 1/2	−21
75.5	26	−1	+1	−2.6
52.3	93	−2 1/2	+2 1/2	−23.2
59.2	46	+1 1/2	−1 1/2	+6.9
65.2	30	+2	−2	+6
70.2	50	+1	−1	+5
70.2	93	0	0	
90.9	138	+1 1/2	−1 1/2	+20.7
103.4	62	+2	−2	+12.5
126.0	75	+3	−3	+22.6
144.4	61	+3	−3	+18.4
121.5	28	−8	+8	−22.9
72.2	76	−6 1/2	+6 1/2	−49.4



ROAD SKETCH, INCLUDING FIELD NOTES

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